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SAND86—2630 • UC—80
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Printed June 1987

Parametric HECTR Calculations of Hydrogen Transport and Combustion at N Reactor

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Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-76DP00789

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

NTIS price codes
Printed copy: A19
Microfiche copy: A01

SAND86-2630
Unlimited Release
Printed June 1987

Distribution
Category UC-80
UNI-4431

PARAMETRIC HECTR CALCULATIONS OF HYDROGEN TRANSPORT AND COMBUSTION AT N REACTOR

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ABSTRACT

This report describes a limited number of parametric calculations of hydrogen transport and combustion in the N Reactor confinement for selected accident sequences. The calculations are performed using the HECTR computer code, which is a lumped-parameter code developed specifically for evaluating hydrogen behavior in reactor containments. A number of parameters are evaluated in this study, including hydrogen source rate, spray effects, and source location. The calculations indicate that mixing within major compartments tends to occur fairly rapidly, but that mixing between compartments can be inhibited in certain situations, resulting in the formation of flammable mixtures. These results are being compared to calculations performed with other computer codes, including a code that uses finite-difference models. United Nuclear Corporation will present the results of these code comparisons in future reports.

ACKNOWLEDGMENT

The authors would like to thank certain individuals who made important contributions to this work. Susan Dingman of Sandia produced many of the HECTR code modifications necessary for this work. D. L. Wegener and Sam Wood of United Nuclear Corporation provided most of the information used in setting up the computer models of N Reactor.

The authors would also like to thank Emily Preston for typing the report.

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EXECUTIVE SUMMARY

United Nuclear Corporation (UNC) is engaged in a number of interrelated programs to assure the safe operation of the N Reactor for the remainder of its planned life. These programs include investigating the potential plant response and risk to the public from a number of postulated severe accident sequences. Some of these accident sequences include the potential for fuel degradation and hydrogen production. UNC has initiated an effort to examine in detail the potential effects of hydrogen released into the confinement and to design any mitigation systems or procedures that are appropriate. UNC has asked Sandia National Laboratories (SNL) to assist in this work by performing analyses of hydrogen behavior within the N Reactor confinement.

Since the accident at Three Mile Island, SNL has been engaged in a program supported by the Nuclear Regulatory Commission (NRC) to examine hydrogen behavior in light water reactor (LWR) containments. A major part of that effort has been the development of the HECTR computer code. HECTR is a lumped-parameter computer code developed specifically for modeling hydrogen transport and combustion in multicompartment reactor containments. HECTR Version 1.5 with additional modifications for the N Reactor confinement was used for the calculations presented in this report.

The N Reactor confinement is a highly compartmentalized structure with a complex arrangement of rooms and flow paths. The confinement consists of two major buildings, the 105 building which contains the reactor, and the 109 building which contains a pipe gallery and a number of steam generator cells. Five, fifteen, thirty-eight, and sixty-five compartment HECTR models were prepared and used in the calculations. All of the important confinement features, such as steam vents, vacuum breakers, and sprays, were included in the models.

Calculations were performed to address a number of issues. Hydrogen sources were examined involving quantities ranging from 88 to 176 kg of hydrogen. Several source locations were investigated including the pipe gallery, the pressurizer penthouse, the steam generator cells, and the reactor pipe barrier space. Calculations were also performed to examine the importance of the spray system and the sump pumps. Finally, some scoping calculations were performed to examine the potential effects of combustion in the 109 building, given a range of arbitrary initial conditions.

A number of important insights were gained from these calculations. Hydrogen released in the lower half of the pipe gallery tends to mix fairly rapidly throughout the 109 building. However, very little hydrogen is transported into

the 105 building in the first few hours because flow is predominantly into the 109 building from the 105 building as a result of condensation in the 109 building and inflow from the filter building to the 105 building. No combustible mixtures were predicted to occur in these cases. Neither changes in the hydrogen source term over the range examined nor turning off the containment sprays appeared to make a major difference in the results. These results are consistent in timing, peak pressure, final hydrogen concentration, and mixing time with the NUSAR Hypothetical Accident.

The most sensitive parameter in these calculations appears to be the hydrogen source location. For example, releases within the pipe barrier space did produce flammable mixtures within the source compartment, but at lean concentrations that were fairly localized. Mixing was reasonably rapid throughout the 105 building (although not rapid enough to prevent the temporarily flammable mixture within the pipe barrier space), with modest amounts of hydrogen being transported into the 109 building.

Releases within the pressurizer penthouse, located on top of the pipe gallery, did result in locally high hydrogen concentrations. This is somewhat a result of modeling the penthouse as a dead-ended volume with only a single flow path connecting it to the pipe gallery; however, it is not unreasonable to expect that hot hydrogen released at a high point will tend to remain high in containment unless driving forces for mixing are present. Containment sprays would be expected to mix the pipe gallery; however, no sprays are located in the penthouse and it is difficult to judge the influence of the sprays located in the pipe gallery on the hydrogen concentration in the penthouse. Future calculations are planned, using more detailed models, to resolve these questions.

Hydrogen mixing following releases within a steam generator cell is very dependent on the level of detail of the model. If the large ducts to the pipe gallery at the top of the cell are modeled as a single junction, then as long as the lower junction (i.e., the sump) is open, a circulation loop is formed between the two junctions. If, however, the sumps become blocked due to high water level and failure of the sump pumps, then HECTR cannot correctly predict circulation into and out of the cells using a single junction. For this case, if the source is in the steam generator cell, then hydrogen accumulation occurs (case 6NS). Using a more detailed nodalization that models the ducts as multiple junctions, results in recirculation through the ducts. In this case (case 10), the hydrogen is rapidly mixed (in ~1000 seconds) into the pipe gallery and only a temporary peak in hydrogen concentration occurs in the steam generator cell.

None of the cases examined resulted in failure of the confinement due to combustion. The quantities of hydrogen in these scenarios are insufficient to lead to failure, provided that the burns are slow enough to result in pressure equilibration throughout the confinement (a few seconds or more). In order to better understand the quantity of hydrogen necessary to pose a substantial threat, we examined the response of the confinement to a number of postulated burns in the 109 building. Several of the parametric calculations predicted relatively uniform hydrogen mixtures throughout the 109 building. Our postulated burn calculations assumed that the confinement was isolated from the outside atmosphere, but did allow pressure relief into the 105 building. These calculations indicate that the confinement design pressure (136 kPa or 5 psig) will be exceeded when the quantity of hydrogen present in the 109 building exceeds 225 - 275 kg (about 5% hydrogen), assuming that the preburn pressure is 1 atm (101.3 kPa).

There are some important limitations that should be remembered when interpreting the results presented in this report. First, this work should be interpreted in the context of a much larger effort that includes calculations using other computer codes and also the identification of important accident sequences. Next, only a limited number of hydrogen and steam source terms were examined, and these source terms were placed in arbitrary locations without calculations of primary system response for each break location. Further, because HECTR is a lumped-parameter code, certain momentum flux and turbulence effects are neglected. The effects of spray entrainment and momentum are also neglected. These code limitations are being examined through comparisons with other codes, including COBRA-NC which contains a finite-difference formulation. Those comparisons will be presented in a future report by UNC. Finally, HECTR does not treat the possibility of flame acceleration or local detonations. No detonable mixtures were predicted for these scenarios; however, in some cases, releases in the pressurizer penthouse and the steam generator cells resulted in situations which could progress to the formation of detonable mixtures.

1. INTRODUCTION

United Nuclear Corporation (UNC) is engaged in a number of interrelated programs to assure the safe operation of the N Reactor for the remainder of its planned life. These programs include investigating the potential plant response and risk to the public from a number of postulated severe accident sequences. Some of these accident sequences include the potential for fuel degradation and combustible gas production.

Combustible gases may be released into the confinement if an accident occurs that is severe enough to lead to fuel degradation and high-temperature metal-steam or graphite-steam interactions. Such interactions are difficult to predict, but could potentially lead to sufficient production of combustible gases, particularly hydrogen, that subsequent combustion could fail the confinement structure. Other efforts are underway to characterize the progression of severe accidents and predict the rate and quantity of hydrogen production. This report deals solely with the behavior of the hydrogen once it is released into the confinement. Most of the calculations use hydrogen and steam releases into the confinement based on the hypothetical accident calculation presented in Reference 4. Some variations of this source are analyzed, and different source locations are postulated; however, no additional core response calculations are presented.

In order to evaluate the potential threat from hydrogen, UNC has initiated an effort to examine in detail the potential effects of hydrogen released into the confinement and to design any mitigation systems or procedures that are appropriate. UNC has asked Sandia National Laboratories (SNL) to assist in this work by performing analyses of hydrogen behavior within the N Reactor confinement. Since the accident at Three Mile Island, SNL has been engaged in a program supported by the Nuclear Regulatory Commission (NRC) to examine hydrogen behavior in light water reactor (LWR) containments. A major part of that effort has been the development of the HECTR computer code [1,2]. HECTR is a lumped-parameter computer code developed specifically for modeling hydrogen transport and combustion in multicompartment reactor containments. HECTR Version 1.5 [2] with additional modifications for the N Reactor confinement building is used for the calculations presented in this report.

The N Reactor confinement is a highly compartmentalized structure with a complex arrangement of rooms and flow paths. The confinement consists of two major buildings, the 105 building which contains the reactor, and the 109 building which contains a pipe gallery and a number of steam generator cells. Our goal is to model the confinement responses in as realistic a manner as possible. Five, fifteen, thirty-eight, and sixty-five compartment HECTR models are used in the calculations. All of the important confinement features, such as steam vents, vacuum breakers, and sprays, are included in the models. In some cases uncertainties exist in parameters such as volumes, surface areas, and actuation criteria; however, we believe that these uncertainties represent second order effects. The dominant uncertainties are those dealing with the hydrogen phenomenology.

Our intention in this study is to characterize the likely nature of hydrogen transport and combustion over a wide range of possible situations. While all possible scenarios cannot be calculated directly, we did perform a number of parametric studies that are presented in this report. Hydrogen sources are examined involving quantities ranging from 88 to 176 kg of hydrogen. Several source locations are investigated including the pipe gallery, the pressurizer penthouse, the steam generator cells, and the reactor pipe barrier space. Calculations are also presented that examine the importance of the spray system and the sump pumps. Finally, some scoping calculations are shown that examine the potential effects of combustion in the 109 building, given a range of arbitrary initial conditions.

There are some important limitations that should be remembered when interpreting the results presented in this report. First, this work should be interpreted in the context of a much larger effort that includes calculations using other computer codes and also the identification of important accident sequences. Next, only a limited number of hydrogen and steam source terms are examined, and these source terms are placed in arbitrary locations without calculations of primary system response for each break location. Further, because HECTR is a lumped-parameter code, certain momentum flux and turbulence effects are neglected. The effects of spray entrainment and momentum are also neglected. These code limitations are being examined through comparisons with other codes, including COBRA-NC [3] which contains a finite-difference formulation. Those comparisons will be presented in a future report by UNC. Finally, HECTR does not treat the possibility of flame acceleration or local detonations. No detonable mixtures are predicted for these scenarios; however, in some cases, releases in the pressurizer penthouse and the steam generator cells result in situations which could progress to the formation of detonable mixtures.

The remainder of this report contains a description of the N Reactor confinement, a discussion of HECTR and the modeling approach used, results from the parametric calculations, and results from the calculations of the postulated burns in the 109 building. Appendices are also included that contain details of the input models and output from the calculations.

2. CONFINEMENT DESCRIPTION

2.1 Introduction

In order to perform hydrogen transport and combustion calculations for postulated reactor accidents and hydrogen releases, we need to construct a detailed model of the physical layout of the plant and the operation of those systems which may affect the confinement response. This model needs to include, therefore, the following kinds of information: 1) physical characteristics of the various volumes into which gas can flow, 2) the characteristics of the flow paths connecting the volumes, 3) the relationship to the outside environment (i.e., leak or vent characteristics), and 4) the characteristics of responding systems which may affect the calculation.

In this chapter, we will give a brief description of the overall confinement arrangement, the leak and junction configuration and the fog spray systems. This information was taken from References 5, 6, and 7. A description of the various models used in the HECTR calculations is presented in Section 3.2 and the details of the input parameter calculations are given in Appendix A.

2.2 General Plant Layout

The N Reactor is located on the DOE's Hanford Reservation in southeastern Washington State, northwest of the city of Richland. The facilities occupy a 90-acre site on the south bank of the Columbia River. Among the many buildings at the site, three are of interest for these calculations: 1) the 105 building - the reactor building, 2) the 109 building - the heat exchanger building, and 3) the 117 building - the filter building. Figure 2.1 shows the general layout of these buildings (primary confinement zone only).

There are five N Reactor building zones, three of which are related to the confinement of radionuclides during accidents. For these calculations, only the primary confinement zone (Zone 1) is of interest. The primary confinement zone encloses the reactor, the primary coolant system, and the reactor gas system. The N Reactor uses a confinement rather than a containment system because of the large exclusion zone and other design features which still allow 10 CFR 100 guidelines to be met [7]. The initial steam burst from a postulated accident is released to the external environment through steam vents which are designed to handle the blowdown of a large break. Then, when the pressure subsides, the steam vents are closed and a filtered vent is opened. The entire primary confinement zone is designed to withstand internal pressures of + 5.0 psig (136 kPa).

2.3 The 105 Building - Zone 1

The general arrangement of the primary confinement zone for the reactor building is shown in Figure 2.2. The reactor core is a cubical volume in the center of the building. Enclosed pipe barrier spaces hang on the front and rear faces of the reactor with wing-like extensions on each side. The graphite gas space, inside the reactor, and the thermal shields are cooled by the graphite and shield cooling system which circulates cooling water from the graphite and thermal shields to the auxiliary room heat exchangers in the 109 building. A 3 psid (20.7 kPad) blowout panel separates the graphite gas space from the rear pipe barrier space. Each pipe barrier space has 18 access holes on top and 18 on bottom. Half the holes are on the left side; half are on the right side. When in operation, the lower holes are bolted shut from the inside. The top holes have hatch covers which are just laid over the hole and will, therefore, open upwards if the differential pressure is great enough (>.21 psid or 1.45 kPad). The pipe barrier spaces are not air tight, but we did not have any quantitative measure of the flow rate and so assumed, for these calculations, that the only gas flow was out of the top holes.

The piping of the primary coolant system enters from the bottom of the 109 building, goes up and over the top of the reactor on the left and right sides, down into the front pipe barrier space, through the reactor into the rear pipe barrier space, down and back into the 109 building to the steam generators.

The volume on each side of and underneath the reactor is not in the primary confinement zone, but is in the secondary confinement zone (zone II). From the side the primary confinement zone looks like an inverted U (See Figure 2.2). The zone starts in the lower front, extends up and over the top of the reactor and excluded side volumes, and down to the lower back. There is a wall separating the front and rear of the building with a two-foot high opening extending all the way across the top.

On the top of the building are three rooms (608, 605, and 604). The front and rear rooms (608 and 604, respectively) are machinery rooms which hold the pipe barrier thermal shields, which are raised when the reactor is shut down. There is a rectangular hole in the floor of each room for the shield to enter. The center room (605) is the exhaust to the filter building. It has nine equally-spaced holes in the floor allowing gas to pass up into the room and then out the three ventilation system confinement exhaust valves to the filter building.

In order to allow gas expansion, there are cross-vents between the 105 and 109 building. There are eight vents, four on each side at the 50-foot elevation. One of the four cross-vents on the right side is normally left fully open. The other seven open if there is greater than a 1.5" wg differential pressure (373 Pad) from the 109 to 105 building. There are shear pins which shear at 2.25 psid (15.5 kPad) differential pressure from the 105 to 109 building. Therefore, if the pressure is greater in the 109 building, the cross-vents act like variable area doors with the area depending on differential pressure. If the pressure is higher in the 105 building, they act as blowout panels.

On the roof of the 105 building are two steam vents and two vacuum breakers. There is one steam vent and one vacuum breaker on each side of the reactor building. On the left side is the special steam vent. On the right is the regular steam vent. The steam vents have covers which rupture at 1.25 psig (109.9 kPa) and 2.0 psig (115.1 kPa), respectively, for the special and regular vent. They have closure valves which close after the initial pressure transient has passed, as described in the section on actuation logic (Section 2.6). The vacuum breakers are operated by reactor building pressure against a weight lever. They begin opening at -.25 psig (99.6 kPa) and are full open at -.5 psig (97.9 kPa).

In the rear of the 105 building, at the bottom, is a junction to the fuel transfer pool. This junction is constructed as a "banana" wall. There is a discharge basin into which part of the rear wall of the reactor building penetrates to a depth which will allow for a $\geq$5 psig ($\geq$ 136 kPa) seal between the inside and outside surfaces of the pool (see Figure 2.2).

After a postulated accident occurs, the fog spray system comes on and injects 8,570 gpm (.54 m**3/s) in order to condense steam, reduce pressure, and scrub fission products. The sprays are auto actuated at 10" wg (103.8 kPa) in the reactor building. The spray nozzles are located on the ceiling of the reactor building so that all areas in the building except for the region directly over and in front of the reactor are covered. The spray region, therefore, forms a U shaped region around the top of the reactor building starting in the front left, going down the left side, across the back, and up the right side to the front.

2.4 The 109 Building - Zone 1

The general arrangement of the primary confinement zone for the heat exchanger building is shown in Figure 2.3. The heat exchanger building is divided into six steam generator cells, an auxiliary cell, a pressurizer penthouse, a large pipe gallery, and an extension to the pipe gallery that was added when steam generator cell six was added.

The pipe gallery is a large open volume with the piping for the graphite and thermal shield and primary coolant systems entering into the bottom third of the gallery and then going to the auxiliary and steam generator cells, respectively. Located in the pressurizer penthouse situated on top of the pipe gallery is a pressurizer which is connected to the hot leg. When a sixth steam generator cell was added, an extension to the pipe gallery was made. The wall at the left end of the pipe gallery has four large open doors connecting the two regions.

There are thirteen regular steam vents and two vacuum breakers located in the pipe gallery. The steam vents are similar to the regular steam vent in the reactor building, blowing open at +2.0 psig (115.1 kPa), and closing at some later time as described in Section 2.6. There are seven steam vents located across from steam generator cell five, four across from steam generator cell one, and two across from steam generator cell six. The two vacuum breakers are similar to those in the reactor building and are located across from steam generator cell one.

The cross-vents from the reactor building enter at the top of the pipe gallery.

The pipe gallery also has a fog spray system. The spray nozzles are equally spaced across the top of the building so that complete coverage is obtained. The drop sizes are larger than those in the reactor building (1690 µm vs. 1400 or 1100 µm). The system is auto-actuated at 10" wg (103.8 kPa) pressure in the heat exchanger building as described in Section 2.6 and injects a total of 1200 gpm (.076 m**3/s).

The steam generator cells each have two steam generators. There are three large ducts at the top of each cell and a sump at the bottom. These all open into the pipe gallery. There are sliding doors which can cover the ducts on any cell isolating it so that maintenance can be performed on one cell while the reactor is in operation. These doors will be covering the ducts on one of the steam generator cells when the reactor is in operation and this cell will not be in operation. Each sump has 10" (.254 m) of water in it when the reactor is in operation and 300 gpm (.019 m**3/s) sump pumps start automatically if the level reaches 12" (.305 m). The sumps are 11 feet (.335 m) deep and 21 feet (6.4 m) wide and extend along the 50-foot width (15.24 m) of the face of the cell.

The auxiliary cell is similar to the steam generator cells but does not have a sump. Instead, it has a small open door about half way up the wall separating it from the pipe gallery. There are four heat exchangers for cooling the graphite and thermal shields in the cell.

There is a fog spray system in the steam generator cells, but actuation of this system is manual. There are no procedures for turning the steam generator sprays on in an accident, so these were not modeled. The auxiliary cell does not have any sprays.

2.5 The 117 Building - Zone 1

The general arrangement of the ducts to the filter building, the filter building, and the vent stack are shown in Figure 2.4. Only the filtered release mode is shown. As described in Section 2.6, all other 105 and 109 building HVAC fans and ducting isolate upon receipt of a 2" wg (101.8 kPa) signal and do not reopen. The gas exits from the 105 building through three 72" butterfly valves (confinement exhaust valves) down an exhaust duct to the filter building, through the "D" cell, into another duct, and then out the vent stack.

The confinement exhaust valves are isolated early in the accident when pressure exceeds 2" wg (101.8 kPa) in the reactor building. Later, these valves reopen if pressure is <3" wg (102 kPa) and 205 s have elapsed (see Section 2.6). At this time, filter cells A and B are in operation. According to procedures, the filters are manually realigned when pressure in zone I falls below 2" wg (101.8 kPa). The "D" cell is put on line and the other cells are isolated. Since the normal filters are not in operation for very long, we only modeled the "D" cell.

2.6 Actuation Logic for Vents and Sprays

There are four actuation circuits which affect the vents and sprays: 1) the 105 confiner circuit, 2) the 109 confiner circuit, 3) the 105 spray circuit, and 4) the 109 spray circuit. The most complicated is the 105 confiner circuit which we will discuss first. All of the circuits are illustrated in Figure 2.5.

2.6.1 The 105 Confiner Circuit

At 2" wg (101.8 kPa), four pressure switches in the 105 building, acting in 2/4 logic, isolate the 105 HVAC system (including the confinement exhaust valves to the filter building) and start three 150 s timers. There is a redundant set of four switches which will also isolate the 105 HVAC system upon start of the ECC systems. When 2/3 of the 150 s timers time out, two things happen: 1) three 55 s timers will start, and after 2/3 of the 55 s timers time out and if 2/4 pressure switches in the 105 building indicate <3" wg (102 kPa), then the confinement exhaust valves to the filter building will open, and 2) if primary system pressure is <575 psig (<4 MPa), all fourteen regular steam vents will close. After the confinement exhaust valves open, the special steam vent closes. If pressure in the 105 building ever increases to >15" wg (105 kPa), then a 2/4 pressure switch logic will reclose the confinement exhaust valves. The valves will reopen if pressure falls back below 15" wg (105 kPa). Note, however, that once the special or regular steam vents close, they will <u>not</u> automatically reopen.

2.6.2 The 109 Confiner Circuit

At 2" wg (101.8 kPa), the 109 building HVAC will be isolated. The logic acts like a 2 out of 7 coincidence circuit where one pressure switch in the pipe gallery and one pressure switch in any one of the steam generator cells will trip the circuit. There is an A and a B train. There are some additional combinations of cell pressures which will trip the logic, but these were not modeled since they are redundant and would not affect the calculations. If the ECC systems start, they will also result in isolating the 109 building HVAC.

2.6.3 The 105 Spray Circuit

Four pressure switches arranged in 2/4 logic will auto-start the 105 building fog spray system if pressure exceeds 10" wg (103.8 kPa) in the 105 building.

2.6.4 The 109 Spray Circuit

Using the same pressure switches and logic of the 109 Confiner Circuit (Section 2.6.2), the spray circuit will auto-start the 109 fog spray system (only in the pipe gallery) if pressure exceeds 10" wg (103.8 kPa) in the 109 building.

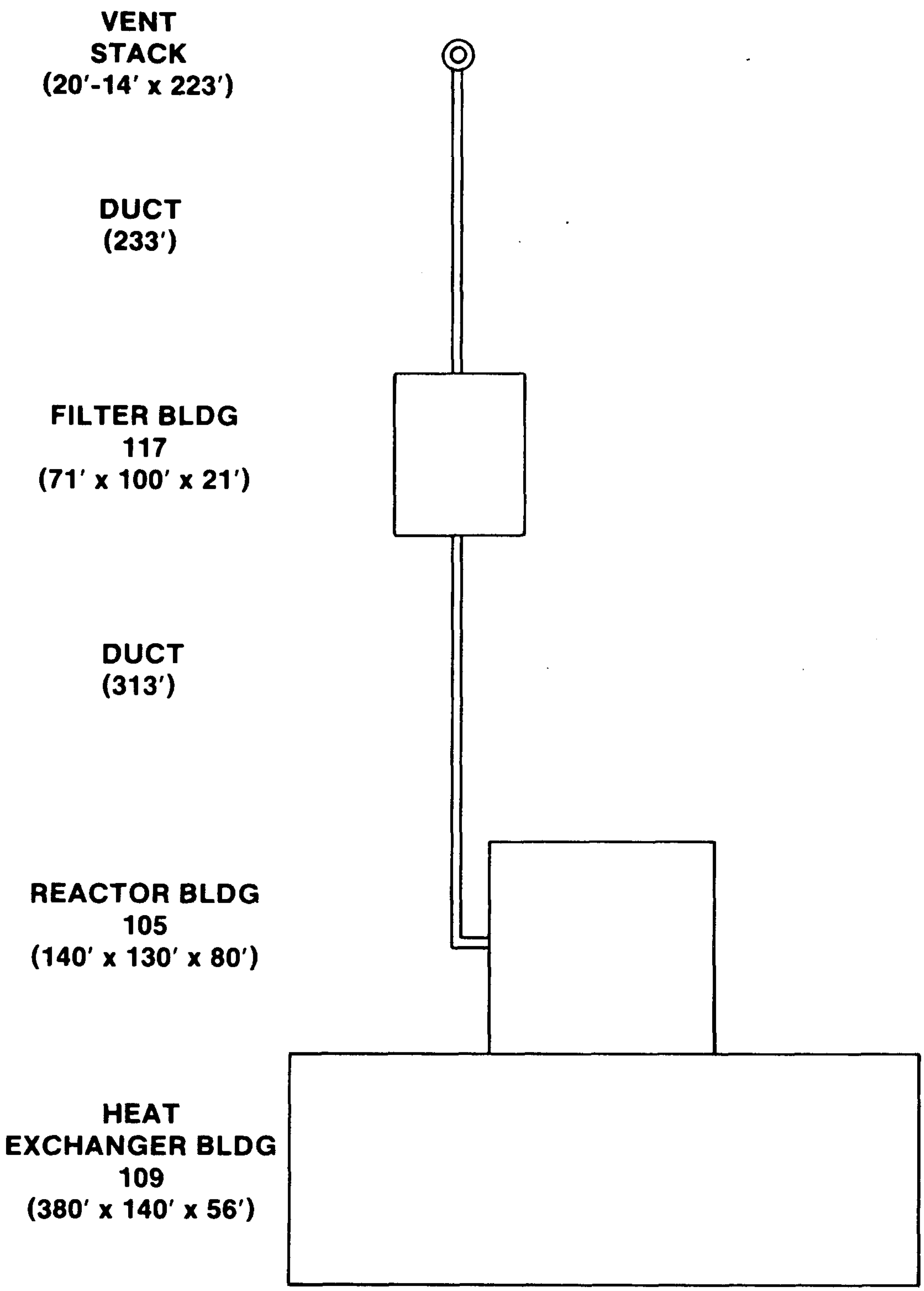


Figure 2.1. General Arrangement of N Reactor Buildings

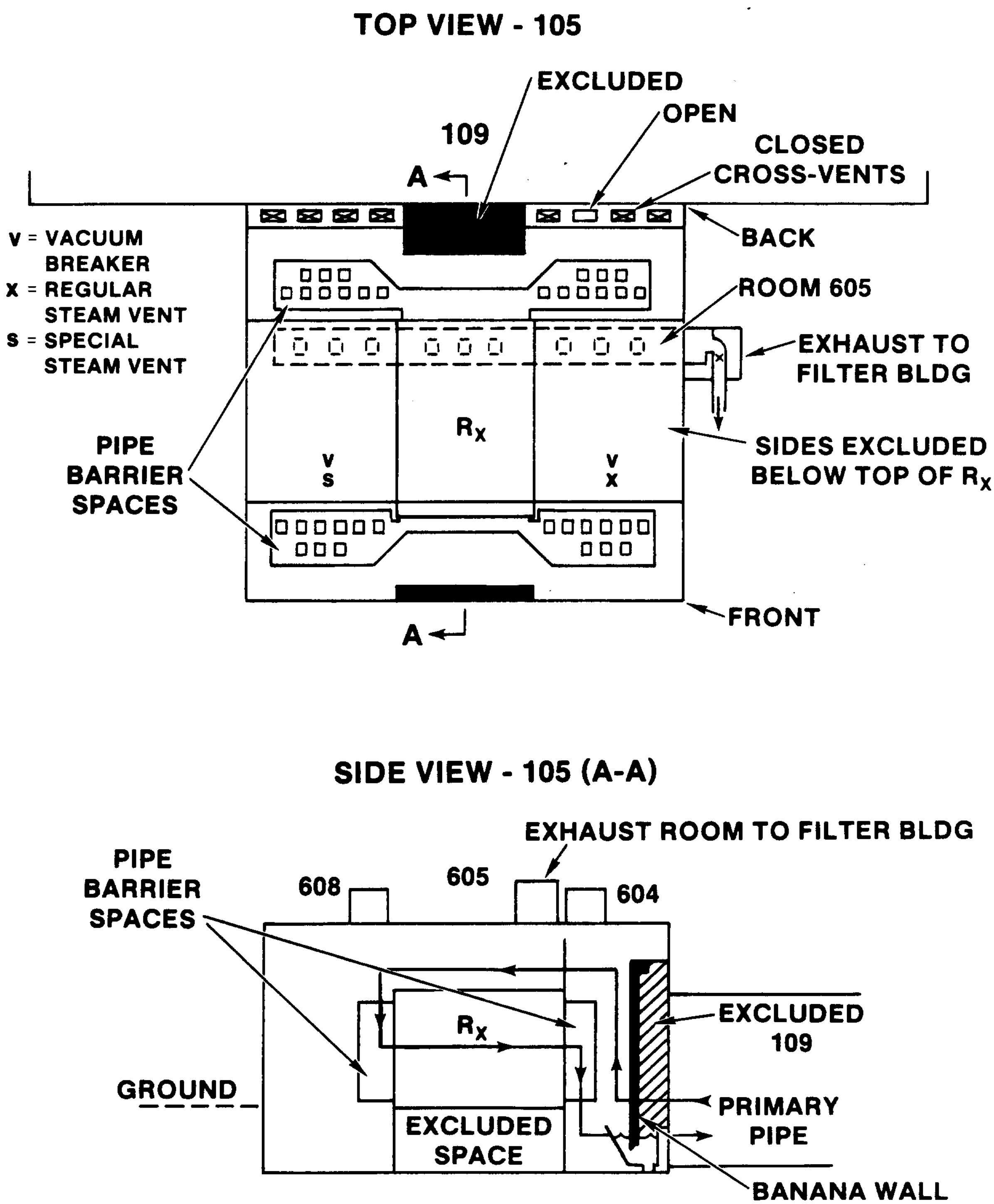


Figure 2.2. Reactor Building - 105

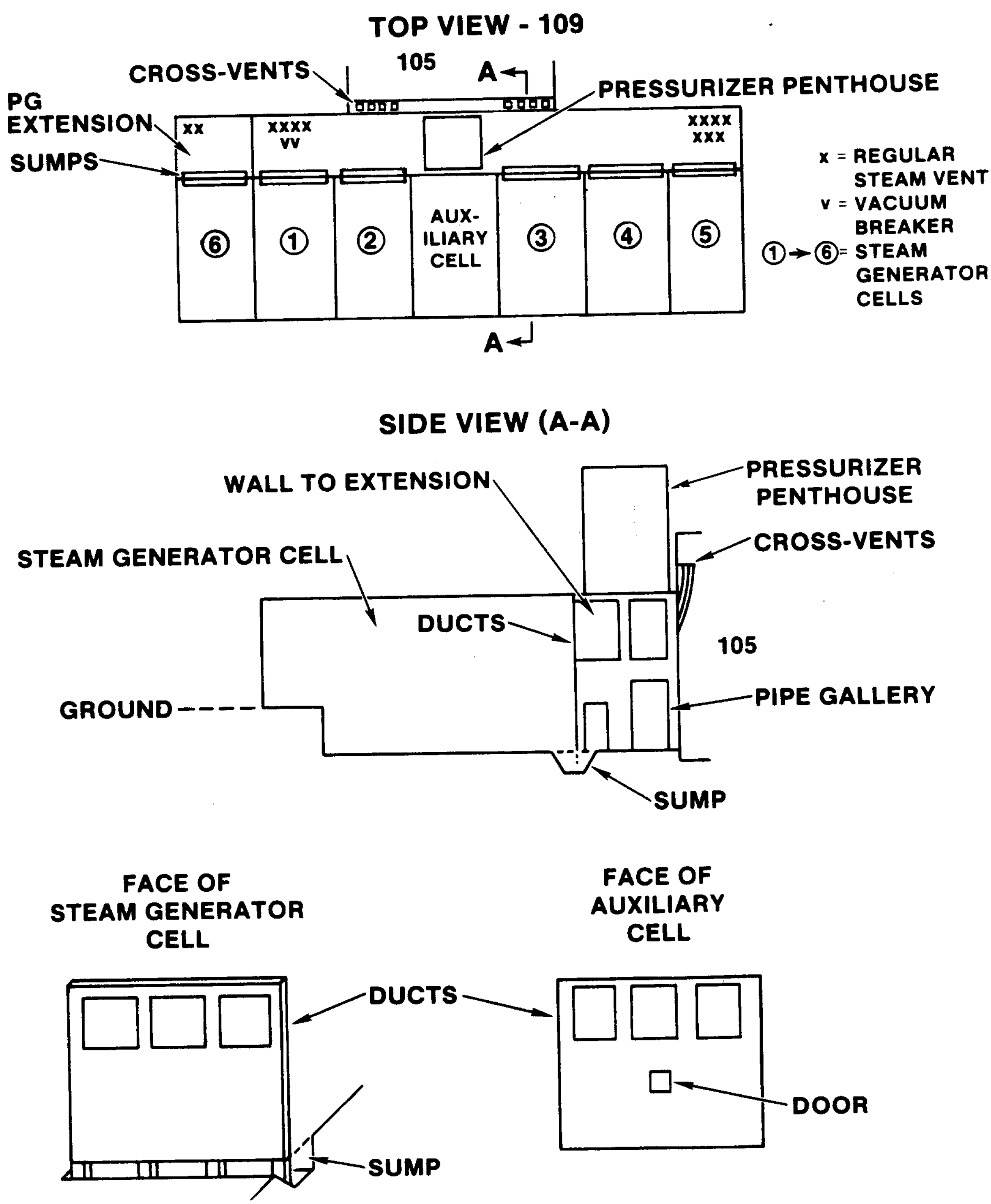


Figure 2.3. Heat Exchanger Building - 109

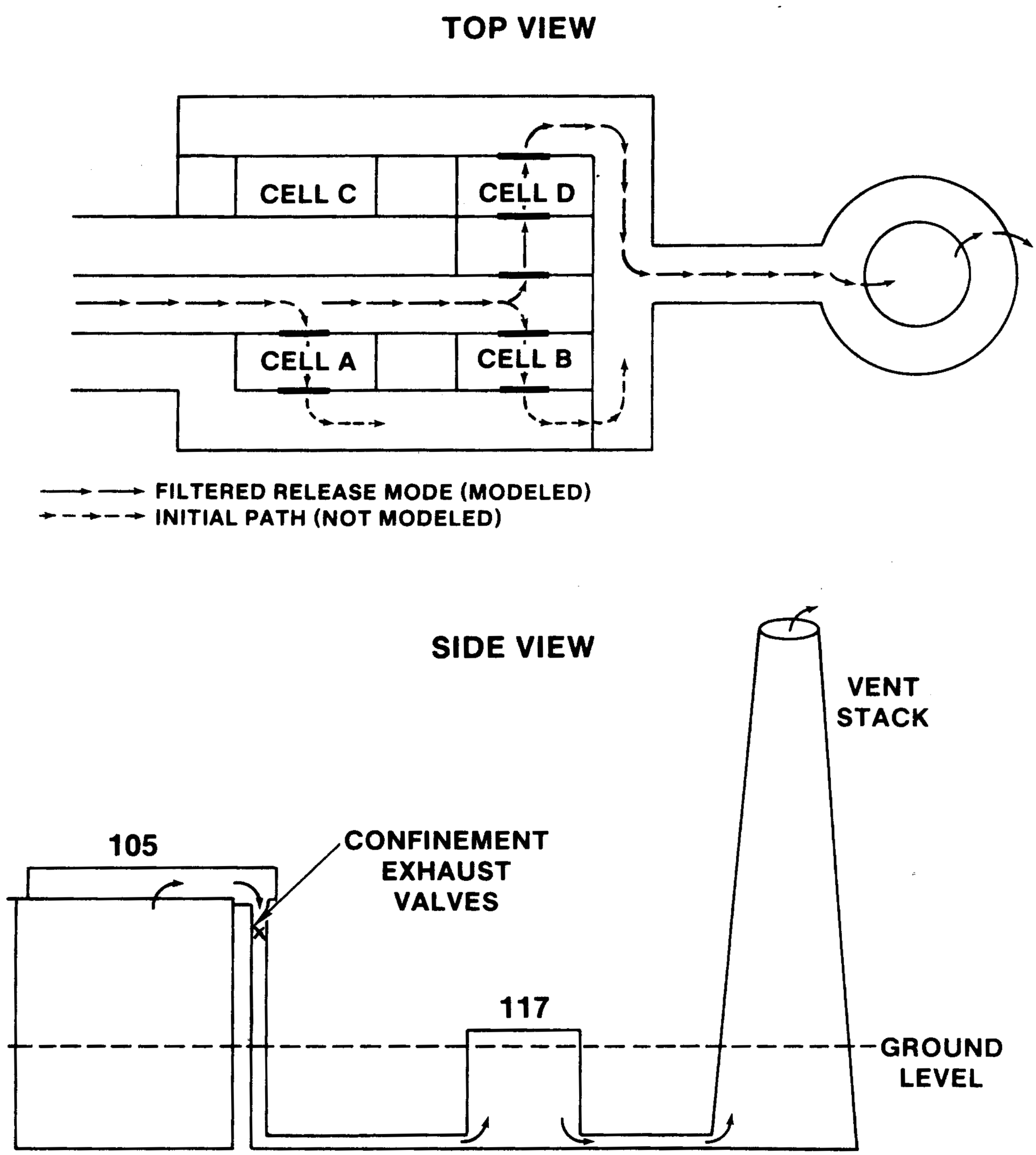


Figure 2.4. Filter Building and Vent Stack - 117

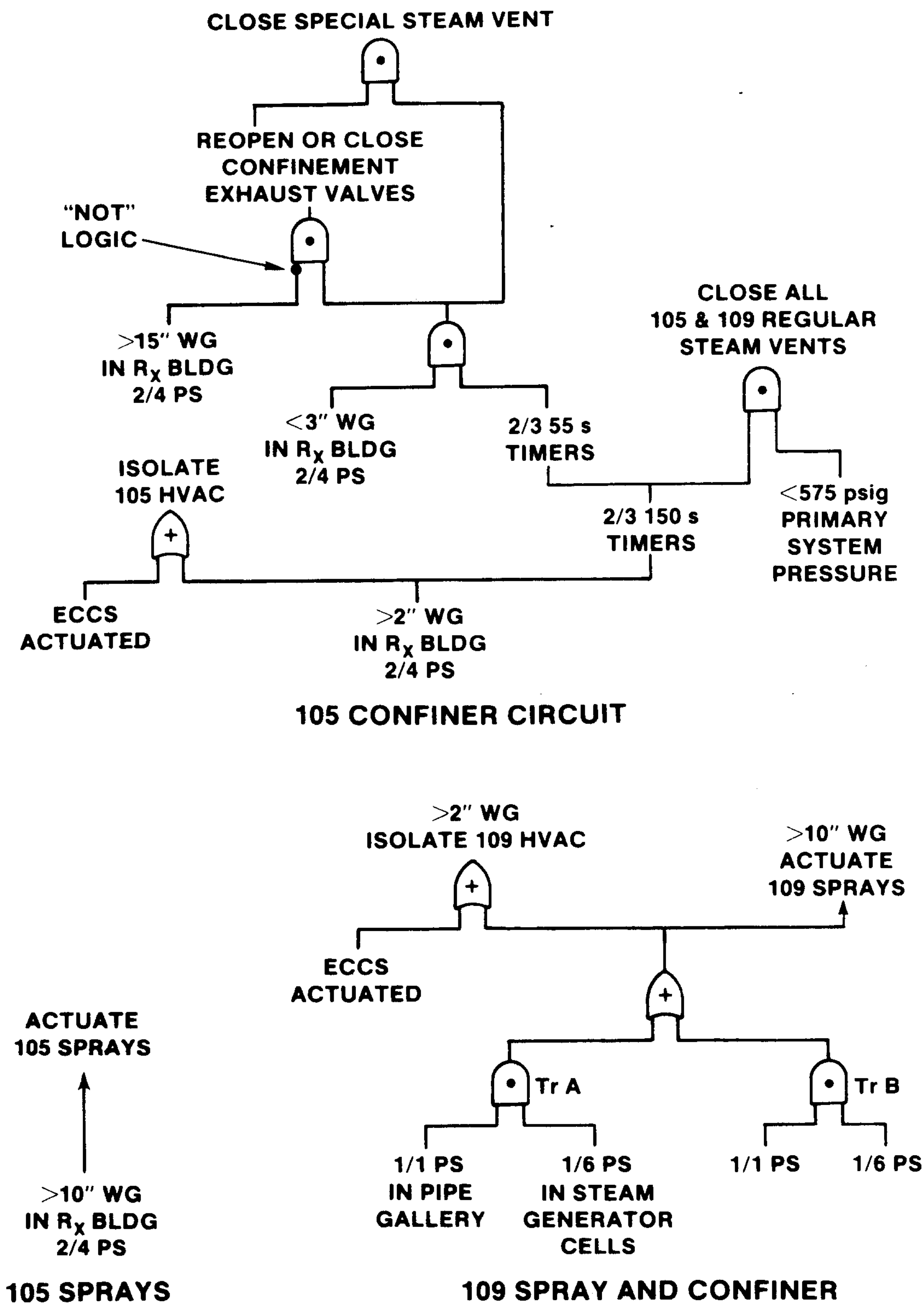


Figure 2.5. Actuation Logic for Vents and Sprays

3. MODELING APPROACH

3.1 Brief Description of HECTR

3.1.1 Introduction

Following the accident at Three Mile Island, the Nuclear Regulatory Commission sponsored a program at SNL to investigate hydrogen behavior in light water reactor containments. A major part of this program was the development of HECTR (Hydrogen Event Containment Transient Response), which is a computer code to model the transport and combustion of combustible gases during postulated accidents in Light Water Reactors (LWRs). Following the development and application of several preliminary versions of HECTR, Version 1.0 was released in February 1985 [1]. This version contained several limitations that were corrected with the release of Version 1.5 in April 1986 [2]. All of the calculations performed for N Reactor are based on HECTR Version 1.5, with some modifications to the code logic, as discussed in more detail later.

HECTR is a lumped-parameter containment analysis code developed for calculating the containment atmosphere pressure-temperature response to combustion. HECTR has been developed with emphasis on combustion. It is not intended to model all possible phenomena that might occur during a severe accident. In particular, steam explosions, core-concrete interactions, and aerosol transport are not modeled by HECTR. References 8 through 12 provide more examples of the previous uses and capabilities of HECTR.

3.1.2 Model Descriptions

In this section, the methods used in HECTR for the N Reactor calculations are briefly described. More detailed discussions of these methods and other models not utilized in these calculations are contained in Reference 2. Changes made to HECTR specifically for the N Reactor calculations will be documented in detail in a future report as a supplement to Reference 2. The code structure and governing equations are discussed first, followed by descriptions of the physical models that provide terms for the governing equations. Section 3.2 contains more information regarding the specific application of these models to N Reactor.

3.1.2.1 Multicompartment Mass, Energy, and Momentum Equations and the Equation of State

To calculate the pressure, temperature, and composition of gases in a containment, the containment is divided into "compartments" with flow between compartments occurring through "junctions." As shown in Figure 3.1, each compartment is essentially a gas control volume. The multicompartment gas-transport model is a system of ordinary differential equations expressing conservation of mass, energy, and momentum. The mass conservation equations are formulated for each gas species in each compartment on a molar basis. HECTR calculations can be performed using either four gas species (water vapor, nitrogen, oxygen, and hydrogen) or six (the previous four gas species plus carbon monoxide and carbon dioxide). The conservation of energy equation is formulated for the total mixture in each compartment. These equations include terms for combustion, heat transfer to surfaces, evaporation/condensation on surfaces, external sources, and the effects of engineered safety features (ESFs). Gas flow rates between compartments and leak rates from the containment are determined by using a simplified momentum equation at each flow junction. A transient momentum equation is used that includes gravitational and frictional forces, but neglects momentum flux terms. Within each compartment the gases are perfectly mixed. Steam is treated as a real gas, while the other gases are assumed to be ideal. The mass, energy, and momentum equations are solved simultaneously to obtain the compartment thermodynamic conditions and junction flow rates throughout a transient. External sources can be treated by HECTR in a variety of ways. Any of the gas species or liquid water can be injected into any compartment or sump. Tabular source input can be provided by the user, or procedures can be used to interface HECTR to source files produced by primary reactor system codes. Energy sources can also be specified for any compartment using tabular input.

3.1.2.2 Method of Solution

The conservation equations in HECTR are solved using a linearized implicit formulation (backward Euler method). The linear system of equations that results from this formulation is solved by a standard LU decomposition followed by back substitution.

3.1.2.3 Timestep Control

There are two major kinds of timesteps in HECTR: heat-transfer timesteps and flow timesteps. Normally, heat-transfer rates are relatively constant over a longer time scale than that required to solve the conservation (flow) equations. Therefore, we decoupled the heat-transfer calculations from the flow equations in HECTR. To accomplish this, heat-transfer rates from radiation, convection, condensation, fan coolers, and sprays are computed at the beginning of a heat-transfer timestep. These rates are then held constant while the flow calculations are performed (the conservation equations are solved). When compartment conditions change sufficiently to significantly affect the heat-transfer rates, HECTR recalculates these rates. The time between heat-transfer updates is termed the heat-transfer timestep, and the timestep used when solving the conservation equations is termed the flow timestep. Note that each heat-transfer timestep can contain one or more flow timesteps.

HECTR automatically controls the size of the heat-transfer and flow timesteps. The flow timestep is controlled by changes in compartment pressure and by the total volumetric flow leaving each compartment. The heat-transfer timestep is controlled by changes in compartment pressures and temperatures. Both types of timesteps are further constrained to fall within minimum and maximum limits. The rate of growth of each timestep is also controlled.

3.1.2.4 Flow Junctions

The standard type of flow junction in HECTR allows for flow in either direction, with the flow rate determined from the momentum equation. Most of the flow junctions in the N Reactor calculations are of this type. HECTR also includes options for several other types of more specialized flow junctions. Two flow junction types are available to model check valves and variable area one-way doors. To model check valves, the momentum equation for two-way junctions is used, but flow is allowed to occur only in one direction. The variable area one-way doors are modeled by allowing the flow area of the junction to vary with the differential pressure across it. A fourth type of junction is used to model drains between the upper and lower compartments of an ice-condenser containment. A fifth type of junction is available for modeling blowout panels. This junction type was used to model the blowout panels around the pipe barrier spaces. The sixth junction type (flood type) is included to model flow paths that may become blocked by water during a simulation. This junction type was used to model the flow path through the sumps connecting the steam generator cells to the pipe gallery.

A seventh type of flow junction was added to HECTR specifically for the N Reactor calculations. This valve-type junction was added to model the cross vents between the 105 and 109 buildings and the isolation valves between the 105 building and the filters. This junction type allows for changing the flow area as a function of differential pressure or time and allows the cross-vent doors to blow out based on exceedence of a specified differential pressure in a given direction. Once the doors blow out, they remain open for the remainder of the calculation.

3.1.2.5 Containment Leakage Model

All flow paths connecting the containment atmosphere to the outside atmosphere are considered to be containment leaks. HECTR includes models for several types of containment leakage:

pressure-dependent leakage, temperature-dependent leakage, and gross containment failure. The leakage area is specified as a function of temperature and time in the temperature-dependent leakage model. For pressure-dependent leakage, the leakage area varies with the differential pressure across the leak. Hysteresis effects can be included in pressure-dependent leakage. Time, pressure or temperature can be used to specify the threshold condition for gross containment failure. When the selected threshold condition is achieved, the leakage area is set equal to the failure area. When more than one type of containment leak is specified for a compartment, the leakage area is calculated as the sum of the leakage areas from the individual models.

Additional leakage models were added to HECTR to treat the N Reactor steam vents and vacuum breakers. The steam vent model allows the vents to open based on time, pressure, or temperature criteria. The vents begin to reclose after a specified time interval and are completely closed after an additional time interval. The vacuum breaker model determines the flow area from a table of area versus differential pressure. Some numerical smoothing of the vacuum breaker areas is employed in the calculations. The steam vent and vacuum breaker models assume constant properties for the outside atmosphere; however, elevation effects (buoyancy terms) are included.

3.1.2.6 Intercompartment Fans

The HECTR fan model can treat flow between any two compartments. A head flow curve can be used to calculate the fan flow rate, or a constant volumetric flow rate can be specified. The fans can be either actuated at the beginning of a calculation or set to come on automatically based on pressure or temperature setpoints. This model was not utilized for the calculations presented in this report; however, it may be modified in the future to treat the N Reactor ventilation system.

3.1.2.7 Hydrogen and Carbon Monoxide Combustion

Two types of combustion models are available for burning hydrogen and/or carbon monoxide in HECTR. The first model is used for "discrete burns" which burn the combustible gases uniformly in a compartment only after prescribed ignition or propagation criteria are met. The second type models "continuous burning" in which the combustible gases are burned continuously as they flow into a specified compartment. These models and the specific correlations are discussed in detail in Section A.2.3 of Reference 2.

The combustion model for discrete burns in HECTR treats both ignition of hydrogen or carbon monoxide in a compartment and propagation of burns between compartments. The burns are assumed to behave like ordinary deflagrations; flame acceleration and detonations are not treated in HECTR. The hydrogen and/or carbon monoxide in a compartment is ignited if the concentrations of hydrogen, oxygen, steam, carbon monoxide, and carbon dioxide in the compartment satisfy specified ignition limits. This burn can propagate into adjacent compartments if the hydrogen, oxygen, steam, carbon monoxide, and carbon dioxide concentrations in these compartments satisfy specified propagation limits, which can be different from the ignition limits. To define the ignition and propagation limits, minimum concentrations are specified for the combustible gases (hydrogen and carbon monoxide) and oxygen, and maximum concentrations are specified for the diluents (steam and carbon dioxide). The propagation limits can be different for upward, horizontal, and downward propagation. The user can specify values for these parameters or use the default values included in HECTR.

HECTR does not model these discrete burns as flame fronts; instead, it calculates a rate at which the hydrogen and carbon monoxide are combined with oxygen in a compartment to form steam and carbon dioxide, and assumes the reaction occurs uniformly throughout the compartment. Thus, during a burn, a compartment will contain a homogeneous mixture of burned and unburned gases. The duration of the burn (the burn time) and the final mole fractions of hydrogen and carbon monoxide are calculated at the start of a burn. A burning rate is then calculated such that the burn finishes at the predetermined time with the correct final mole fractions of hydrogen and carbon monoxide. The burning rate is adjusted at each timestep during the burn to account for changes in the hydrogen and carbon monoxide concentrations from flows into or out of the compartment. A burn will terminate if all the oxygen in the compartment is consumed.

The burn time can be a user-specified constant, or it can be calculated as the ratio of a user-specified flame propagation length (travel distance) to the flame speed. The flame speed can be calculated from a default correlation that varies with the concentrations of the combustible gases and diluents, or it can be specified as a constant by the user. The mole fractions of hydrogen and carbon monoxide that will remain at the end of the burn can also be calculated from a correlation built into HECTR, or they can be specified as constants by the user. The default combustion completeness and flame speed correlations were derived from a variety of experiments that were performed in the Variable Geometry Experimental System (VGES) and Fully Instrumented Test Series (FITS) experimental facilities at SNL [13,14] and at the Nevada Test Site (NTS) [15]. The default combustion completeness correlation has been upgraded from the correlation used in HECTR Version 1.0 [1] to include more recent experimental results.

The continuous burning model consumes combustible gases as they flow into a compartment, rather than allowing the gases to accumulate to a minimum concentration before burning them. In this option, a user-specified fraction of the total inflowing combustible gases is burned whenever user-specified criteria for continuous burning in the compartment are satisfied. The criteria checked are: a minimum inflow rate of combustible gases, a maximum ratio of diluent to combustible gas inflow rates for the compartment, a minimum oxygen concentration in the compartment, and a maximum diluent concentration in the compartment. In addition, if the temperature in the compartment exceeds a user-specified "spontaneous recombination temperature," continuous burning will be allowed, even if the other criteria for continuous burning are not satisfied.

3.1.2.8 Radiative Heat Transfer

The radiative heat-transfer model in HECTR includes radiation from the steam, carbon monoxide and carbon dioxide in the compartments to the surfaces, as well as radiative exchange among the surfaces. The gas and the surfaces are both assumed to be gray. When carbon monoxide and carbon dioxide are not included in a calculation, the emittance of steam is calculated using the Cess-Lian model [16]. For calculations that include carbon monoxide and carbon dioxide, a single equivalent band approximation based on the Edwards wide-band model [17] is used to calculate the emittance.

Surface emissivities, and view factors and characteristic beam lengths between surfaces, are provided by the user. A network for radiative heat transfer among the surfaces is then constructed, and the resulting linear system of equations is solved to give the net heat flux to each surface. In HECTR, radiative exchange is recommended only between surfaces in the same compartment or in adjacent compartments.

3.1.2.9 Convective Heat Transfer

The convective heat-transfer package in HECTR contains models for sensible heat transfer, latent heat transfer (evaporation and condensation), and liquid films. Three basic types of surfaces are treated: walls, sumps, and ice-condenser surfaces. The sensible heat transfer to each surface is determined using correlations for the Nusselt number. Both free and forced convection solutions are calculated, then the larger heat flux is used.

Two types of latent heat-transfer models are included in HECTR: air-steam diffusion models and pure steam models. Both evaporation and condensation are treated in HECTR. The air-steam diffusion model is used whenever a significant amount of air is present and is based on a heat-transfer/mass-transfer analogy relating the Sherwood number to the Nusselt number that is calculated for sensible heat transfer. Steam partial pressure differences between the gas and the surface provide the driving force for mass transfer (either evaporation or condensation).

Different pure-steam latent heat-transfer models are used for the different types of surfaces. A modified Nusselt film model is used for condensation on wall and ice-condenser surfaces. Condensation on sump surfaces is based on a heat-transfer boundary layer at the top of the sump surface.

Liquid films are allowed to build up on wall surfaces only. The films can build up to a specified maximum film thickness. Any additional condensate will be added to a specified sump. Changes in film thickness are based on the calculated evaporation or condensation rate. If the film becomes superheated relative to the gas, a portion of the film will boil or flash in order to bring the film back to saturation.

To aid in NRC licensing calculations, the correlations for convective heat transfer and condensation specified in Reference 18 are also included in HECTR as an option.

3.1.2.10 Surface Conduction

The surfaces in HECTR are treated either as one-dimensional slabs or as lumped masses. For both cases, the heat transfer to the front side of the surface is calculated from the models for radiative and convective heat transfer described in Sections 3.1.2.8 and 3.1.2.9.

For lumped-mass surfaces, the temperature and all of the material properties are assumed to be constant throughout the surface. Therefore, a simple energy balance using the net heat-transfer rate to the surface can be integrated to give the transient surface temperature.

One-dimensional conduction is modeled for slab surfaces. Three types of boundary conditions can be specified for the back sides of slabs: insulated, constant temperature, or constant heat-transfer coefficient. The slab is nodalized by HECTR, and a finite difference formulation is used to calculate the temperatures in the slab.

3.1.2.11 Containment Sprays

The containment spray model determines the heat and mass transfer rates in containment due to sprays. The effects of sprays on the fluid mechanics (momentum and turbulence effects) are not included. Sprays can be injected into any specified compartment. The drops from containment sprays are assumed to be isothermal, spherical, and traveling at the terminal velocity corresponding to their instantaneous size and mass. Ordinary differential equations are formulated, which express the rates of change of the mass and temperature of a drop with respect to the distance it has fallen. These equations are integrated for drops from each drop size in a user-specified droplet distribution as they fall through a compartment. The contribution of the sprays to the heat- and mass-transfer rates for the compartment are determined by the final temperature and masses of the drops. The gas is assumed to be homogeneous with constant properties during the fall time of the drops. Therefore, the solutions represent a quasi-steady-state model. A user-specified fraction of the drops that have reached the bottom of a compartment is allowed to fall into lower compartments. Water not falling into other compartments can be transferred to a specified sump.

Like the fans, the sprays can be either actuated at the start of a calculation or set to come on automatically whenever specified pressure or temperature setpoints are exceeded. The spray actuation logic was altered for the N Reactor calculations to allow spray actuation based on combinations of pressure signals from various compartments, and to allow different spray trains to have different actuation criteria. Additional logic in HECTR allows operation of the sprays in either the injection mode or the recirculation mode. In the injection mode, sprays are introduced from a constant-temperature external source. After a specified time in the injection mode, the sprays automatically switch to the recirculation mode. In the recirculation mode, spray water is drawn from a specified sump and, if desired, passed through a heat exchanger before being introduced into the desired compartments. All of the N Reactor calculations were performed in the injection mode.

3.1.2.12 Containment Sumps and Water Pools

An arbitrary number of sumps can be included in a simulation, and each sump can reside in an arbitrary number of compartments (this is accomplished by using multiple surfaces for a sump). The temperature of each sump is assumed to be uniform, even for sumps that reside in more than one compartment. Water and energy can be added to or removed from each sump by several processes that are listed in the following paragraphs. The temperature and mass of each sump are calculated by performing mass and energy balances that include all of these processes. Each sump can be either subcooled or saturated (at the minimum pressure of the compartments containing the sump). If a sump becomes superheated, enough water is removed from the sump during each timestep and added as steam to the associated compartments to keep the pool at saturation.

Water can be added to the sumps by several processes: runoff of condensate that collects on heat-transfer surfaces, water that condenses from the atmosphere if the gas becomes supersaturated, condensate from a fan cooler, and water that drains out of the lower plena of an ice condenser. Any spray droplets that reach the bottom of a compartment and which will not be carried over into lower compartments are also added to a sump. If an external source of water is injected into a compartment and flashes to a mixture of liquid and steam in the compartment, the liquid portion is added to a sump. External sources of liquid water or any of the gases modeled in HECTR can also be injected directly into a sump. Any steam injected into a sump is assumed to condense in the sump, and any other gases are assumed to be cooled to the sump temperature before escaping into a user-specified compartment(s). The energy removed from the gases by condensation and cooling is added to the sump. Water can be drawn from a sump for emergency core cooling or containment sprays. Water can also overflow from one sump to another.

Sumps can be cooled by heat exchangers, and convective heat transfer, condensation/evaporation, and radiative heat transfer are calculated for the surfaces of each sump.

A model also exists to treat boiling water reactor (BWR) Mark III suppression pools. This model was not employed in these calculations, but may be modified in the future to treat the banana wall in the 105 building.

3.2 Confinement Model Descriptions

In this section, we will discuss the physical and logical characteristics of the four models of the N Reactor constructed for this analysis. The detailed calculations of the specific numbers used may be found in Appendix A.

Initially, we based our model on a 12-volume model that was developed for the CONTEMPT code [5] and informal information from UNC describing calculations of areas, volumes, and flow coefficients for the vents, leaks, and junctions [5]. Descriptions of the fog spray system, and the vent and leak logic were also provided. As questions came up, we called the plant and obtained additional information; however, there are still some uncertainties and discrepancies. We feel that all of these will have minor effects on the calculation and discuss some of them in Section 3.2.4. The rest are discussed in Appendix A in the parameter calculations.

3.2.1 The 5-Volume Model

In order to perform some initial scoping calculations on the potential effects of combustion in the 109 building, a simple 5-volume model was constructed. While this model lumps together large volumes of the primary confinement zone, the logic and characteristics of all the leaks, vents, and junctions are modeled in the same manner as in the 15 and 38-volume models. This allowed us to test the changes made to HECTR in order to model the vent and junction characteristics at N Reactor.

Figure 3.2 shows the overall layout of the 5-volume model and identifies all the leaks, vents, and junctions. The leaks and vents are numbered L1 to L11; the junctions are numbered J1 to J7.

The reactor building is divided into two volumes: the front (volume 1) and the rear (volume 2). The front volume includes the front pipe barrier space, room 608 (a machinery room), and room 605 (the exhaust to the filter building inside the confinement exhaust valves). The rear volume includes the rear pipe barrier space, the graphite gas space, and room 604 (a machinery room).

The two vacuum breakers make up leak 4; the regular steam vent is leak 5; the special steam vent is leak 11, and there are two leaks (10 and 9) which represent small leakages from the front and rear, respectively. Junction 1 is the two-way open junction at the top of the wall separating the front and rear volumes. Junction 2 represents the three confinement exhaust valves to the filter building. Junction 5 is the open cross-vent between the 105 and 109 buildings. Junction 6 is made up of the seven normally-closed cross-vents between the 105 and 109 buildings.

The heat exchanger building (109) is also divided into two volumes; the pipe gallery (volume 3) and the steam generator and auxiliary cells (volume 4). The pipe gallery volume includes the extension added when steam generator cell 6 was added.

Leaks 2, 3, and 6 are small leakages from the steam generator cells (L2 and L3) and the pipe gallery (L6). Leak 7 represents the 13 regular steam vents in the pipe gallery. Leak 8 represents the two vacuum breakers in the pipe gallery. Junction 3 represents the 21 ducts from the pipe gallery to the top of the steam generator and auxiliary cells (3 per cell). Junction 4 is the door to the pipe gallery halfway up the face of the auxiliary cell. Junction 7 represents the 6 sumps connecting the pipe gallery to the six steam generator cells.

The filter building, vent stack, and connecting ducts are volume 5. Leak 1 is the two-way open exhaust to the atmosphere.

The fog spray systems spray uniformly into volumes 1 and 2 for the 105 system and volume 3 for the 109 system. The systems are adjusted to spray the correct amount of water into each volume.

3.2.2 The 15-Volume Model

In order to perform baseline comparisons among several codes and also to obtain some preliminary information about hydrogen transport in the 109 building, a base case problem was defined (see Chapter 4). For this base case problem, a 15-volume model was constructed which divided the pipe gallery into 11 volumes in order to see what flow patterns developed.

Figure 3.3 shows the overall layout of the 15-volume model and identifies all the leaks, vents, and junctions. The leaks and vents are numbered L1 to L13; the junctions are numbered J1 to J29.

The reactor building (105) is divided into two volumes: the front (volume 1) and the rear (volume 2). The front volume includes the front pipe barrier space, room 608 (a machinery room), and room 605 (the exhaust to the filter building inside the confinement exhaust valves). The rear volume includes the rear pipe barrier space, the graphite gas space, and room 604 (a machinery room).

The two vacuum breakers are combined to form leak 4, the regular steam vent is leak 5, the special steam vent is leak 13, and there are two leaks (12 and 11) which represent small leakages from the front and rear, respectively. Junction 1 is the two-way open junction at the top of the wall separating the front and rear volumes. Junction 2 represents the three confinement exhaust valves to the filter building. Junction 8 is the open cross-vent between the 105 and 109 buildings. Junction 9 represents the three normally closed cross-vents on the same side as the open cross-vent. Junction 10 represents the four normally closed cross-vents on the other side.

The heat exchanger building (109) is now divided into 12 volumes. The steam generator and auxiliary cells are lumped into one volume (volume 14) and the pipe gallery is divided into 11 volumes. The pipe gallery extension is volume 3, the pressurizer penthouse is volume 13, and the main area is divided into three levels with three volumes on each level. The top of the lowest level is the bottom of the cold leg inlet manifold so that a break there occurs in volume 8. The two upper levels evenly divide the rest of the height. Volumes 4, 7, and 10 are in front of steam generator cells 1 and 2; volumes 5, 8, and 11 are in front of the auxiliary cell, and volumes 6, 9, and 12 are in front of steam generator cells 3, 4, and 5.

Leaks 2, 3, and 6 are small leakages from the steam generator cells (L2 and L3) and the pipe gallery (L6, placed in volume 6 where the hatch to the access corridor is located). Leaks 7, 8, and 9 contain 2, 4, and 7 regular steam vents, respectively. Leak 10 represents the two vacuum breakers in the pipe gallery.

Junctions 3, 4, 5, and 6 represent the ducts from the top of the steam generator and auxiliary cells into the pipe gallery. Junction 3 represents the ducts for steam generator cell 6; junction 4 represents the ducts for steam generator cells 1 and 2; junction 5 represents the ducts for the auxiliary cell, and junction 6 represents the ducts for steam generator cells 3, 4, and 5. The connecting sump from the pipe gallery to steam generator cell 6 is junction 11; the sumps for steam generator cells 1 and 2 are included in junction 12; the auxiliary cell door is junction 7 and the sumps to steam generator cells 3, 4, and 5 are included in junction 13. Junctions 14 through 25 are the fully open junctions between volumes in the main area of the pipe gallery. Junction 26 is the junction to the pipe gallery from the pressurizer penthouse. Junctions 27 through 29 are the open doors from the main area of the pipe gallery into the extension (volume 3).

The filter building, vent stack, and connecting ducts make up volume 15. Leak 1 is the two-way open exhaust to the atmosphere.

The fog spray system in the 105 building sprays into volumes 1 and 2. The fog spray system in the 109 building sprays into volumes 3, 10, 11, and 12 and then the drops fall through into the appropriate lower volumes if not evaporated. The flow rate is apportioned for each volume.

3.2.3 The 38-Volume Model

In order to perform detailed calculations of the hydrogen transport in the primary confinement zone for postulated accidents occurring in various places in the zone, a detailed 38-volume model was constructed. This model was designed to model features which could affect the transport and buildup of hydrogen in various areas of the primary confinement zone.

Figures 3.4 a, b, and c, show the layout of the 38-volume model and identify all the leaks, vents, and junctions. The leaks and vents are numbered L1 to L25; the junctions are numbered J1 to J64.

The reactor building is now divided into 19 volumes. The front of the reactor building (volume 1 in the 5- and 15-volume models) is divided into 11 volumes and the rear (volume 2 in the 5- and 15-volume models) is divided into 8 volumes. The top level of the reactor building is divided into 10 volumes: volume 1 - the top right front, volume 2 - the top center front and room 608, volume 3 - the top left front, volume 4 - the top right center over the excluded space on the right side of the reactor, volume 5 - the top center directly over the reactor, volume 6 - the top left center over the excluded space on the left side of the reactor, volume 7 - the top right rear, volume 8 - the top center rear and room 604, volume 9 - the top left rear, and volume 38 - the 605 room on top of the building up to the confinement exhaust valves. The lower region next to the front face of the reactor is divided into four volumes: volume 10 - the lower right front, volume 11 - the lower center front, volume 12 - the lower left front, and volume 16 - the front pipe barrier space. The lower region next to the rear face of the reactor and the reactor itself is divided into five volumes: volume 13 - the lower right rear, volume 14 - the lower center rear, volume 15 - the lower left rear, volume 17 - the rear pipe barrier space, and volume 18 - the graphite gas space inside the reactor.

Leak 16 represents the two vacuum breakers in the reactor building (according to more recent information, this is modeled incorrectly: there should be one vacuum breaker in volume 6 and another in volume 4. See Section 3.2.4 on limitations. This error will not have significant impact on the scenarios considered and will be corrected for future calculations). Leak 17 is the regular steam vent and Leak 25 is the special steam vent. Leaks 24 and 23 are small leakages from the front and rear of the reactor building, respectively.

Junctions 1, 2, and 3 are the two-way open junctions at the top of the wall separating the front and rear of the reactor building. Junctions 4, 5, and 6 are the two-way open hatches (three in each junction) connecting the reactor building to the 605 room which is the exhaust room to the filter building. This room, on the roof, extends across the center of the building. Junctions 7, 8, 9, and 10 are the closed hatches on the side wings of the front (J7, J8) and rear (J9, J10) pipe barrier spaces. Junction 11 is the blowout panel from the reactor graphite gas space (volume 18) into the rear pipe barrier space (volume 17). Junction 12 represents the confinement exhaust valves to the filter building. Junction 21 is the open cross-vent; junction 22 represents three of the closed cross-vents, and junction 23 represents four of the closed cross-vents into the pipe gallery. Junctions 46 through 64 are the full open junctions between volumes in the reactor building.

The heat exchanger building (109) is divided into two general areas, each of which is subdivided into smaller volumes: the pipe gallery (11 volumes) and the steam generator and auxiliary cells (7 volumes). We will discuss each of these separately.

As shown in Figure 3.4.c, the pipe gallery is divided as in the 15-volume model into: volume 19 - the pipe gallery extension in front of steam generator cell 6, volume 29 - the pressurizer penthouse, and a main area of three levels with three volumes per level (volumes 20 to 28). The top of the lower level in the pipe gallery is at the level of the bottom of the cold leg inlet manifold and the upper levels split the remaining height. Volumes 20, 23, and 26 are in front of steam generator cells 1 and 2, volumes 21, 24, and 27 are in front of the auxiliary cell; and volumes 22, 25, and 28 are in front of steam generator cells 3, 4, and 5.

Leak 18 is a small leakage from the pipe gallery into the access corridor in volume 22. Leaks 19, 20, and 21 represent the regular steam vents in the pipe gallery (in volumes 19, 26, and 28, respectively). Leak 22 represents the two vacuum breakers in the pipe gallery (in volume 26).

Junctions 13, 14, 15, 16, 17, 18, and 19 represent the ducts from the pipe gallery to top of the steam generator cells 6, 1, and 2, the auxiliary cell, and steam generator cells 3, 4, and 5, respectively. Junction 20 is the auxiliary cell door. The sumps connecting the pipe gallery and steam generator cells 6, 1, 2, 3, 4, and 5 are junctions 24, 25, 26, 27, 28, and 29, respectively. Junctions 30 through 41 are the full open junctions between volumes in the pipe gallery. Junction 42 connects the pipe gallery to the pressurizer penthouse. Junctions 43 through 45 are the open doors connecting the pipe gallery and the extension in front of steam generator cell 6.

The steam generator and auxiliary cells are each modeled separately. The steam generator cells are volumes 30, 31, 32, 34, 35, and 36; the auxiliary cell is volume 33. Leaks L2 through L15 are small leakages from the cells.

In the reactor building (105) the fog spray system sprays into volumes 1, 3, 4, 6, 7, 8, and 9. The rates are calculated for the number and size of nozzles in each volume. If appropriate, a portion of the spray drops which reach the bottom of the volume fall through to the lower volumes. In the heat exchanger building (109) the sprays spray into volumes 19, 26, 27, and 28 in the pipe gallery and fall through as appropriate into lower volumes.

3.2.4 The 65-Volume Model

After running the initial parametric cases and comparing them with preliminary COBRA-NC results, it became clear that the gas transport into cells with only one junction was not adequately modeled. Two cases in particular reflect this situation: 1) the case with the source in the pressurizer penthouse (case 5), and 2) the case with the source in the steam generator cells when the sump was blocked during the blowdown (case 6NS). For sources in the penthouse, we still expect high concentrations due to the stratification of the hot hydrogen being injected and the absence of sprays in this compartment. However, for the steam generator cells, we would expect, as a result of the detailed nodalization results of the COBRA-NC calculations, that significant mixing would occur through the large ducts at the top of the cells due to temperature differences (density) and condensation effects. The 65-volume model was constructed to see if, with increased nodalization, HECTR could reproduce the COBRA-NC results. More detailed comparisons between HECTR and COBRA-NC will be performed later to see if the difference in the modeling of the physics or the level of nodalization are most important in driving any differences that may appear.

For the 65-volume model (see Figures 3.5a and b), the reactor building and filter building were modeled as in the 15-volume model. A comparison of the circulation patterns in the pipe gallery and steam generator cells for releases in these volumes showed that the detail of modeling in the reactor building had no significant effect. The pipe gallery, steam generator cells, and auxiliary cell were modeled as in the 38-volume model except for steam generator cell 6 and the pipe gallery extension. These two compartments were subdivided into 33 and 13 volumes, respectively. This allowed the three ducts at the top of the steam generator cell to be split in two horizontally and modeled as six separate junctions. The sump connecting the steam generator cell to the pipe gallery was also split into three junctions. These junctions are shown on Figure 3.5.b. The junctions between all the compartments in the steam generator cell and pipe gallery extension are too numerous to show, but can be found in the input deck for the 65-volume model in Appendix E. The sprays in the pipe gallery extension were apportioned equally into the top level of cells. All other leaks, junctions and sprays in the 109 building were modeled as in the 38-volume case.

3.2.5 Limitations of Models

In this section, we will discuss various limitations on the models themselves. Limitations on the calculated values of various parameters are discussed in Appendix A.

<u>Limitations on All Models</u>

1) The top ducts on one steam generator are normally blocked by sliding doors, since the reactor normally operates with only five of the six steam generator cells in operation. In our model, all ducts are modeled as open. For accidents outside of the cell, this would significantly reduce the transport of hydrogen into the blocked-off cell, although it would still act as a pressure absorber due to the sump junction. This would result in a small increase in average hydrogen concentrations elsewhere. This will be changed at the plant and the doors will be positioned such that they do not block any of the ducts except when maintenance is actually being performed.

2) We modeled the filter building assuming only the spare filter cell "D" was operating. When the confinement exhaust valves reopen at 3" wg (102 kPa), cells "A" and "B" will be operating. However, the operator is directed to open cell "D" and isolate cells "A" and "B" when pressure drops to 2" wg (101.8 kPa) which, in fact, occurs a very short time later. Since conditions are not changing very rapidly at this time, the slight difference in flow coefficients due to the differing volumes, etc. will not have a significant effect. The one filter can adequately handle the flow at this time.

3) Due to insufficient information at the time the model was constructed, we modeled the 109 pressure as also actuating the timers in the 105 confiner circuit. However, since the buildings both exceed 2" wg (101.8 kPa) pressure within a fraction of a second of each other for the large blowdowns being analyzed, this makes no practical difference in the time of operation of the regular and special steam vents and the confinement exhaust valves.

4) The complete set of switch combinations for actuation of the 109 building isolation and sprays was not modeled. Because any of these alternate paths will have the same effect on the timing of events that the modeled path has, only one path needed to be modeled.

5) Actuation of the emergency core cooling systems (ECCS), which also actuates portions of the 105 and 109 confiner circuits, was not modeled. Since the confinement pressure exceeds 2" wg (101.8 kPa) almost immediately (i.e., < .1 s) and, since the ECCS actuation should also take place immediately, the primary confinement zone was assumed to be isolated initially for all of our calculations. If some time elapsed before isolation, this would tend to reduce the peak pressure somewhat, depending on the time necessary to isolate. This would not affect the hydrogen transport, which occurs after this time.

6) We assumed that primary system pressure would always be below 575 psig after the blowdown, since the only cases analyzed are a postulated large break. This means that the regular steam vents will always close after the 150 s timers time out.

7) The confinement exhaust valves to the filter building were modeled as reclosing after their initial opening at 205 s if the pressure increased above 15" wg (105 kPa) and reopening if the pressure dropped back to below 3" wg (102 kPa). Better information, obtained

later, shows that they reopen if pressure falls back below 15" wg (105 kPa). This only affects burn calculations since the pressure spike may result in the vent closing and then reopening after the burn is over and the pressure decreases. This would not affect the burn itself and was observed to have no significant effect after the burn, since the pressure fell almost immediately back to 3" wg (102 kPa) anyway.

8) The sump pumps for the steam generator cell sumps were not modeled, except for breaks in a steam generator cell where the sump for that steam generator cell would fill up and result in reduced circulation between the cell and the pipe gallery. This allows significant hydrogen buildup in the cell (see parametric case 6 and 10). For all other cases, the blowdown does not fill up the sumps and the sprays, which are assumed to remain on for all but parametric case 8, slowly fill them up. The sumps are just getting full at about 13,000 s after most of the hydrogen has been released and mixed. Since we do not know the dominant accident sequences which will show up in the probabilistic risk assessment (PRA), we decided to model this conservatively. If the sprays were off or if the sump pumps were on, the mixing rate would increase due to the sump junction remaining open.

9) For volumes connected to the rest of the confinement by only one junction, the amount of circulation through the junction may not be adequately modeled in HECTR. For large open junctions, convection loops may form within the junction. A COBRA-NC calculation is being performed with detailed nodalization of some volumes and junctions to determine the possible magnitude of these effects. Volumes connected by one junction tend to act like a spring and some small amount of numerical mixing is predicted in some cases. The 65-volume model was constructed in order to compare a more detailed HECTR nodalization with both the COBRA-NC results and the 38-volume model for case 6NS where this effect was observed. A comparison of case 6NS and case 10 (the 65-volume model) show that HECTR will predict circulation if the nodalization is adequate.

Limitations on the 5 and 15-Volume Models

1) Due to the insufficient nodalization of the reactor building and the steam generator cells, detailed hydrogen transport for postulated accidents in enclosed volumes such as the pipe barrier spaces and the individual steam generator cells can not be

adequately modeled. Also, for the 5-volume model, accidents in the pressurizer penthouse could not be realistically modeled.

2) Since the steam generator cells are not separated in these models, horizontal circulation into these cells through the ducts created by the differential pressures in the pipe gallery would be possible. By comparing the results of the 15- and 35-volume models, this was found not to significantly affect the results.

3) Differential hydrogen accumulation can not be correctly modeled in the reactor building with so few volumes.

Limitations on the 38-Volume Model

1) The vacuum breakers in the reactor building are both modeled as being on the left side, in volume 6. In fact, one is on the left and the other is on the right, in volume 4. Early in the postulated accidents, this results in some asymmetry in the flow patterns, particularly for parametric case 4 in the reactor building. Since the vacuum breakers open after the blowdown and close before any significant hydrogen transport, the effect on the calculations was relatively minor.

2) The sump junctions to the steam generator cells 1 through 5 are connected to the pipe gallery incorrectly. They are connected to the top of the pipe gallery (volumes 26 and 28), not the bottom (volumes 20 and 22). This will impact the mixing rate. Some cases were rerun correcting this error and no observable differences were noted. This error affected only the air flow path, not the water accumulation in the sump.

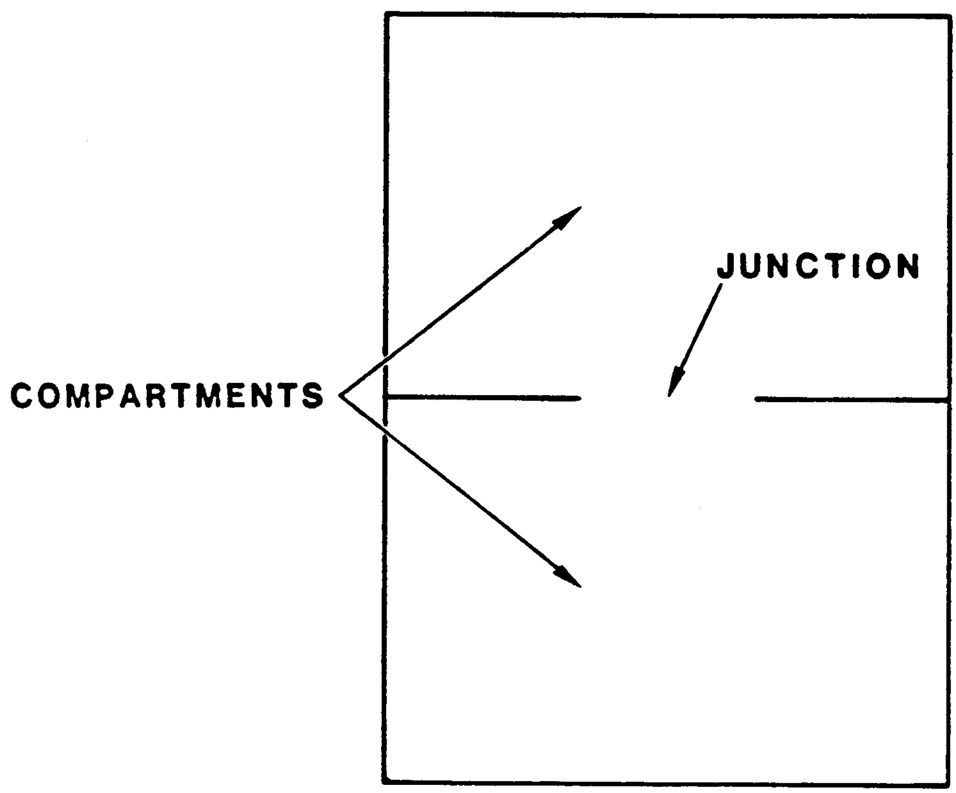


Figure 3.1. HECTR Compartment and Junction Arrangement

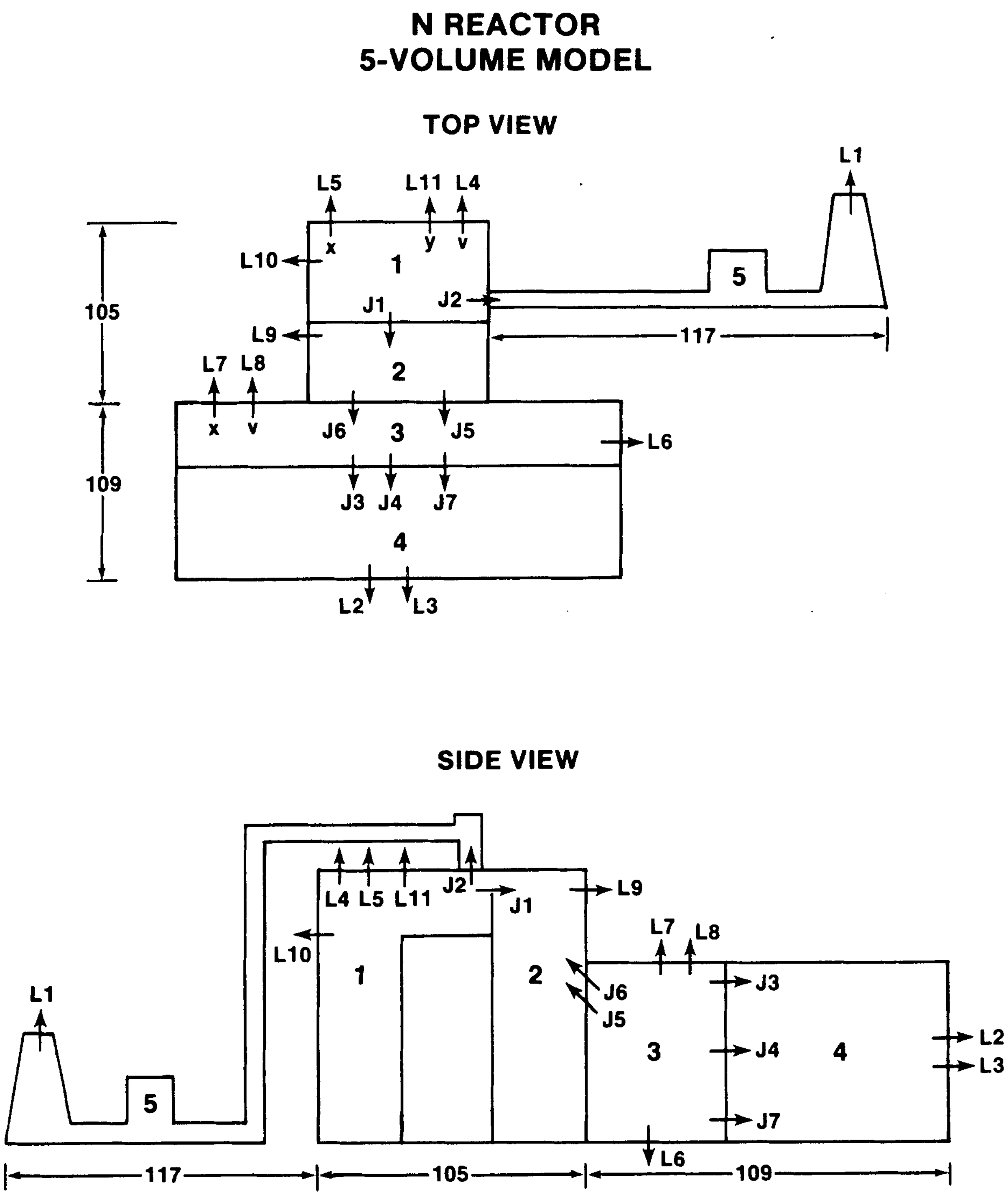
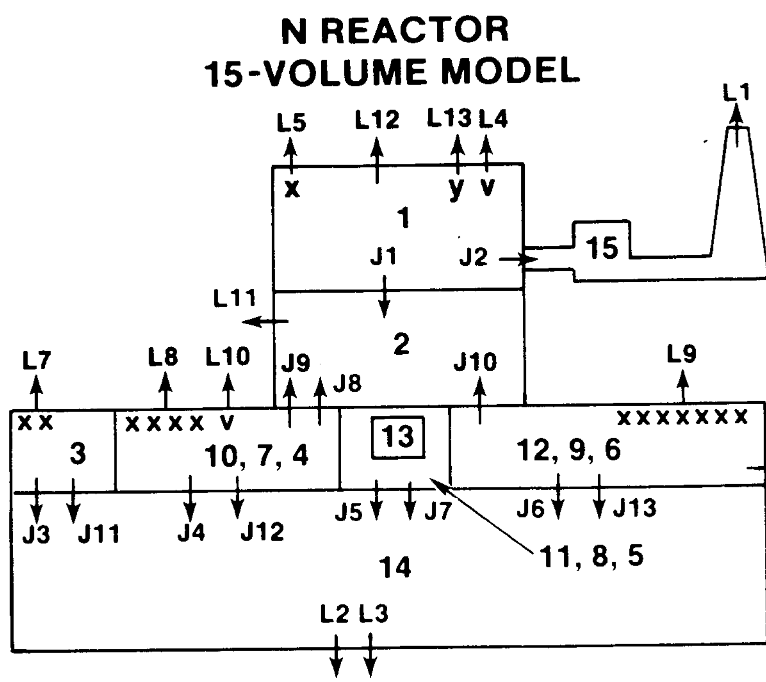


Figure 3.2. 5-Volume Model



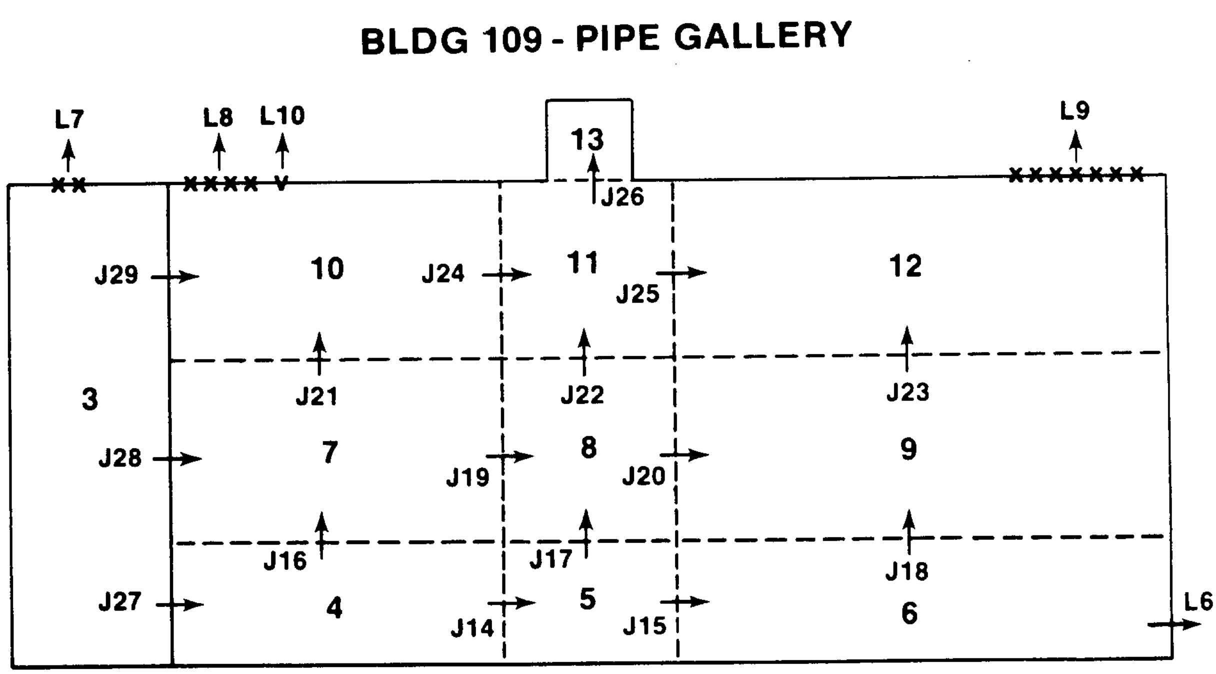


Figure 3.3. 15-Volume Model

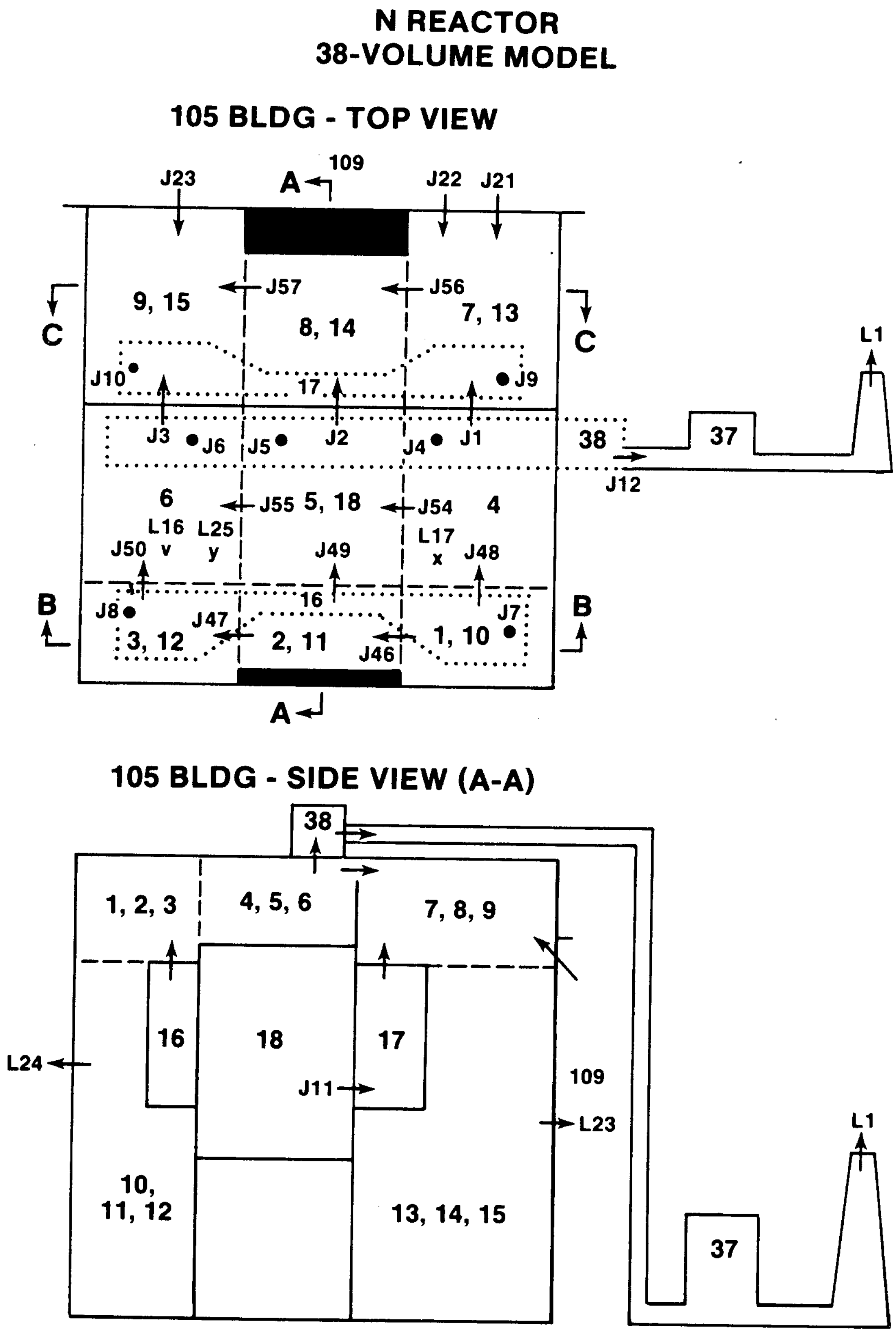
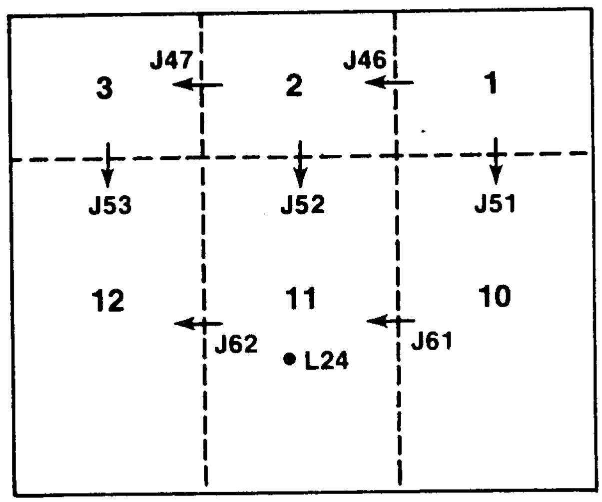


Figure 3.4a. 38-Volume Model

105 BLDG - FRONT VIEW (B-B)



105 BLDG - REAR VIEW (C-C)

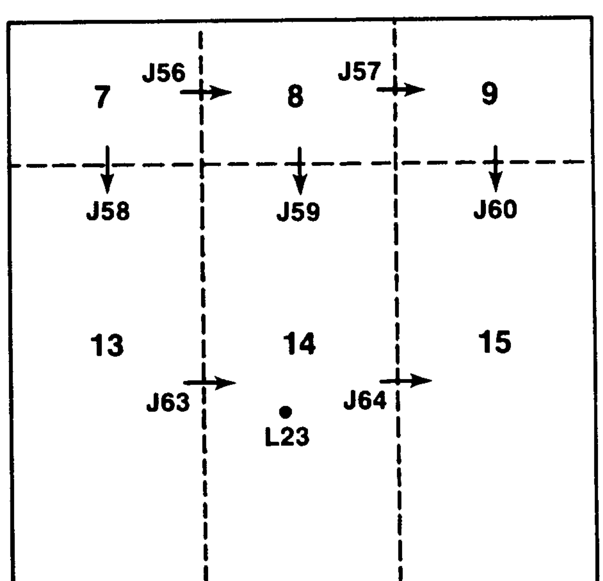
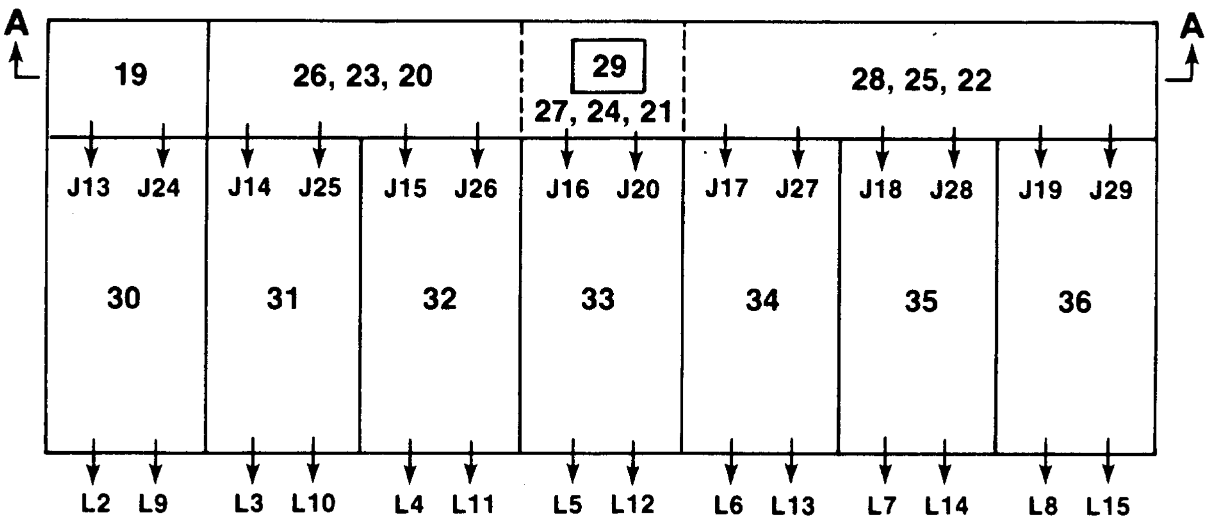


Figure 3.4b. 38-Volume Model (Continued)

109 BLDG - TOP VIEW



109 BLDG - PIPE GALLERY (A-A)

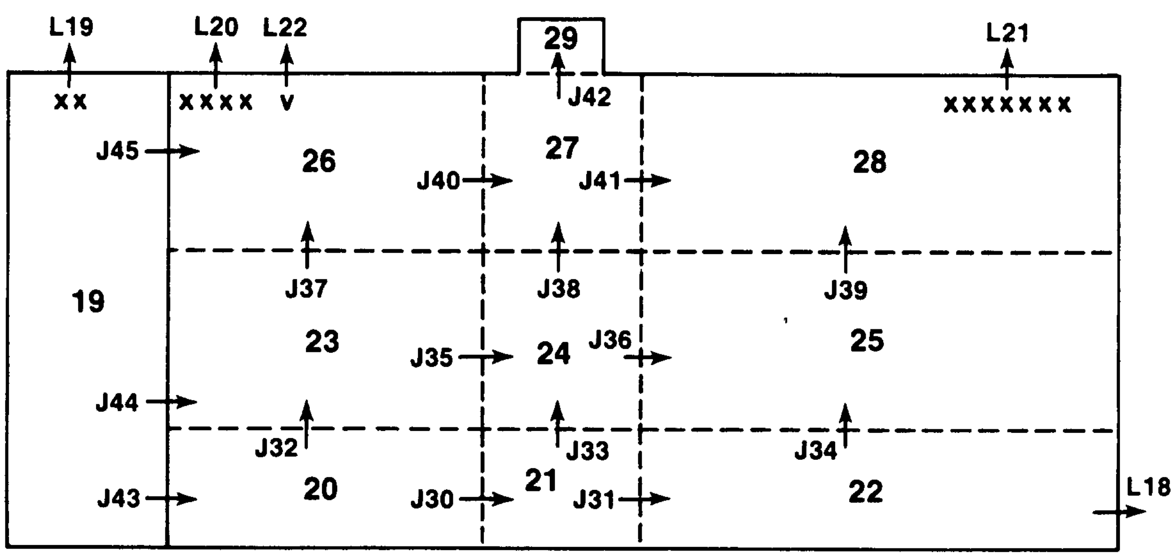


Figure 3.4c. 38-Volume Model (Continued)

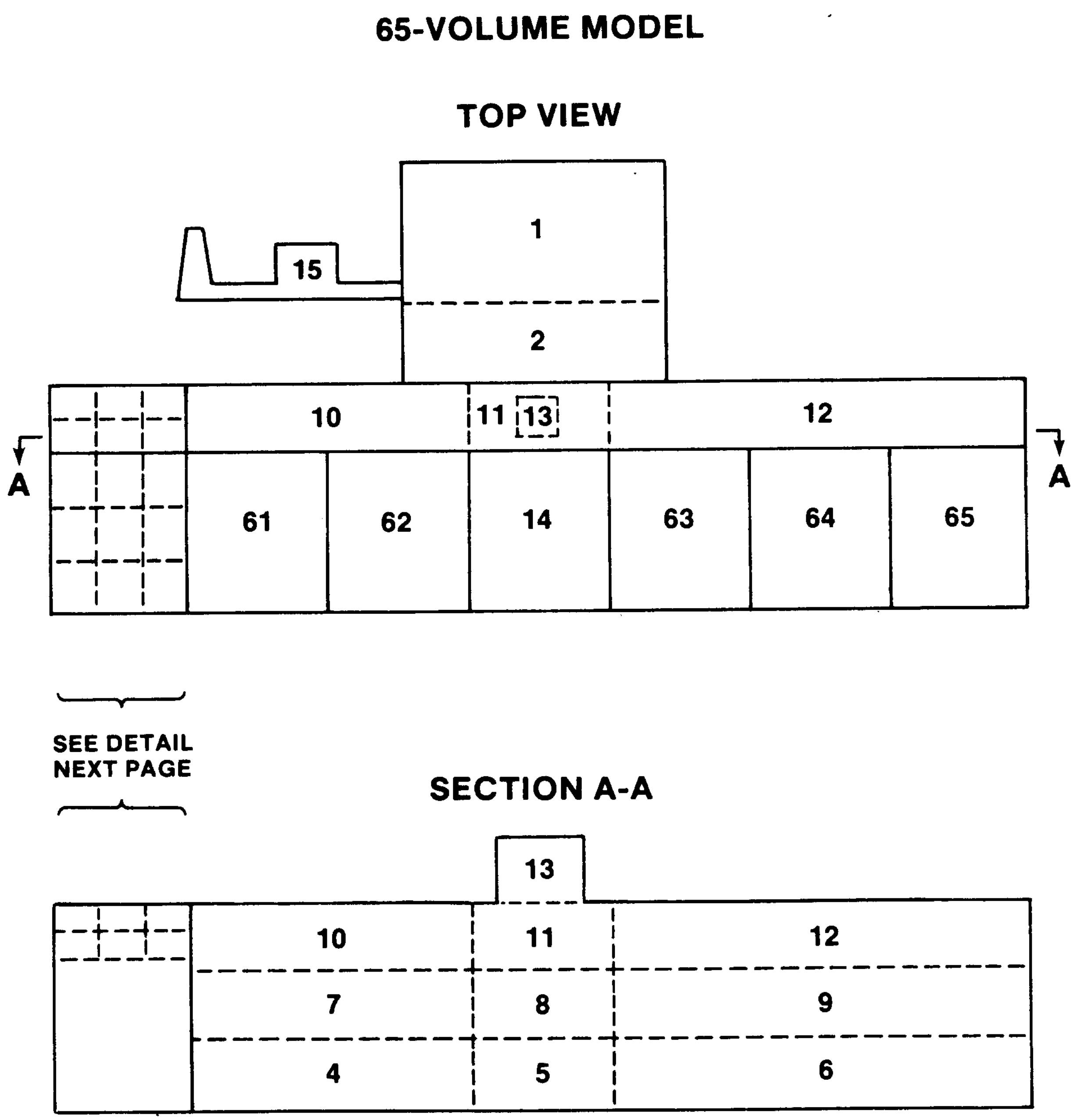


Figure 3.5a. 65-Volume Model

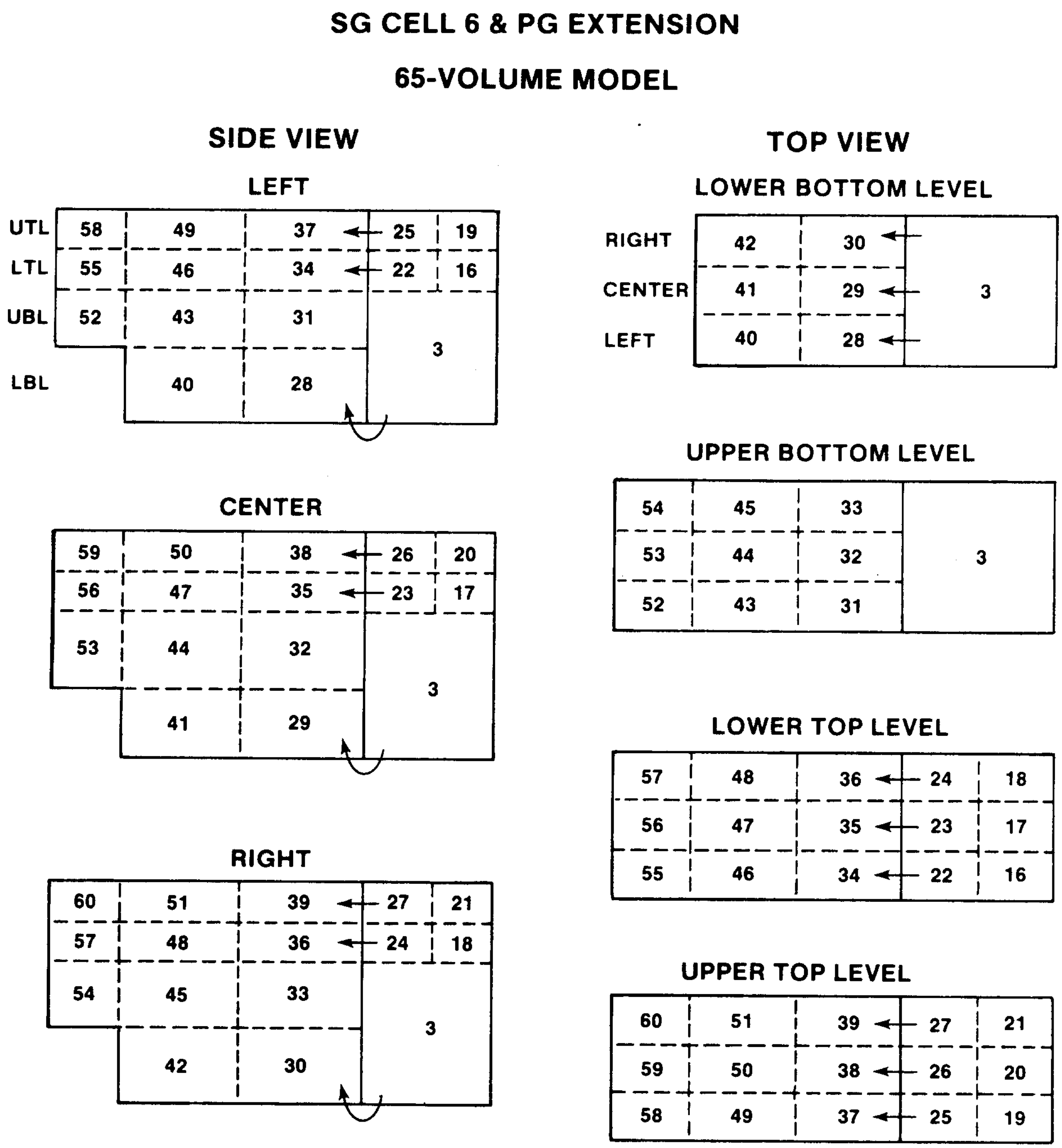


Figure 3.5b. 65-Volume Model (Continued)

4. BASE CASE RESULTS (CASE 1)

4.1 Introduction

The base case was a postulated large break in the primary system cold leg inlet manifold with failure of emergency core cooling. The case was analyzed using the 15-volume model. The break was located in volume 8, and the fog sprays were left on after they were actuated. The steam and hydrogen sources were for the NUSAR hypothetical accident sequence [4], but the hydrogen source was extended to 13,000 s by UNC [5].

4.2 The First 500 Seconds

The steam source begins at t = 0, peaks at t = 0.6 s, and decays to zero at t = 156 s. Figure 4.1a and b show the steam and water injection rates and Figures 4.2a and b show the integrated totals. The split between steam and liquid is based on a HECTR calculation that flashes the primary system fluid to a saturated mixture at the compartment pressure.

As shown in Figure 4.3 and 4.4, the pressure in the 109 building exceeds 1.5" wg (101.4 kPa) at t = .09 s and the differential pressure results in the cross-vents to the 105 building beginning to open. At t = 0.1 s, the pressure in the 109 building exceeds 2" wg (101.8 kPa) and the 109 building isolates. As shown in Figure 4.5, the pressure in the 105 building exceeds 2" wg (101.8 kPa) at t = .36 s, and the 105 building isolates. Also at t = .36 s, the pressure exceeds 10" wg (103.8 kPa) in the 109 building and the 109 fog spray system is actuated (flow does not occur for another 44 s). At t = 0.7 s, the pressure exceeds 10" wg (103.8 kPa) in the 105 building and the 105 fog spray system is actuated (flow does not occur for another 44 s). At t = 1.7 s, the pressure exceeds 2.0 psig (115.1 kPa) in the 109 building and the regular steam vents open (see Figure 4.6). At the same time, the pressure in the reactor building exceeds 1.25 psig (109.9 kPa), and the special steam vent opens (Figure 4.7). At t = 3.4 s, the pressure exceeds 2.0 psig (115.1 kPa) in the 105 building and the regular steam vent opens (Figure 4.8). Due to the large blowdown, the pressure continues to increase until the relief capacity of the vents matches the blowdown. The pressure in the 109 building peaks at t = 10.5 s at 3.41 psig (124.8 kPa) (Figure 4.3), which is below the design pressure of 5 psig (136 kPa) for the primary confinement. The pressure drops rapidly after the peak due to continued venting. Further reduction of the pressure and temperature occurs due to spray injection at t = 44.4 s in the 109 building and t = 44.7 s in the 105 building; spray injection results in substantial steam condensation which causes the pressure to go subatmospheric at t = 76 s. The larger negative pressure in the 109 building results in closure of seven of the eight 105-109 cross-vents at t = 112 s (Figure 4.4).

The regular steam vents begin closing at t = 150 s and are completely closed by t = 175 s (Figures 4.6 and 4.8). The pressure eventually goes below -.25 psig (99.6 kPa) at t = 183 s resulting in the vacuum breakers opening in both the pipe gallery and the reactor building (Figures 4.9 and 4.10). At t = 205 s, the confinement exhaust valves open, allowing inflow through the filter building (Figure 4.11). The special steam vent begins closing at t = 205 s and is completely closed by t = 220 s (Figure 4.7). At about t = 375 s in the 105 building, t = 430 s in the 109 building, the vacuum breakers reclose as the flow through the filter building is now adequate to keep the buildings pressurized (Figures 4.9 and 4.10).

4.3 Long-Term Behavior

Hydrogen production first becomes significant at about t = 160 s. It peaks at t = 832 s and then declines out to t = 13,000 s where the calculation ends. The original NUSAR hydrogen source went to 7,200 s and was linearly extended until the rate was .5 scfs by UNC. Figure 4.12 shows the hydrogen source rate and Figure 4.13 the integrated hydrogen injection.

At about t = 500 s, air flow from the outside is entering through the filter building into the 105 building and then into the 109 building due to the steam condensation. Very little hydrogen is, therefore, transported into the reactor building until late in time when, due to the source term and reduction in condensation, the flow reverses and a small outflow out of the filter building results in a slow transport of hydrogen into the reactor building starting at about t = 7,300 s (Figure 4.14). Maps of the junction flow directions at 3,000 and 10,000 s are shown in Figures 4.15 and 4.16.

By examining Table 4.1, one can see that, initially, differentials exist in hydrogen concentrations between the source volume and other volumes in the pipe gallery. Later, recirculation loops are established that mix the region uniformly in about 3,000 seconds, with the exception of the pressurizer penthouse (see Figures 4.15 and 4.16). Very little hydrogen is transported into this dead-ended region since only one junction connects it to the other volumes and no recirculation loops can form. This is probably not correct and is a likely result of inadequate nodalization. Even if the volume mixed, it would not significantly change the results. Figure 4.17 shows the hydrogen concentration in the source compartment (volume 8).

Figure 4.18 and Table 4.1 show that hydrogen from the pipe gallery is transported into the steam generator and auxiliary cells due to recirculation loops formed by the ducts at the top of the cells and the sumps and auxiliary cell door lower down. The sumps do not fill during the blowdown and, even if the sump pumps do not operate, the sprays do not completely fill the sumps until near the end of the run when all flow through the sumps would cease. A recirculation loop exists, therefore, that transports hydrogen into volume 14 (Figures 4.15, 16 and 19). If the pumps operated, the sump junctions would remain open since the pumps have enough capacity to balance the spray flow.

In either case, the hydrogen in the cells would be uniformly mixed with the pipe gallery by the end of the run at t = 13,000 s.

Table 4.1 shows the hydrogen concentrations for all of the compartments at selected time intervals. No flammable mixtures occurred in any volume, due to the small quantity of hydrogen involved and the relatively rapid mixing.

Table 4.1

HYDROGEN CONCENTRATIONS FOR CASE 1

	TIME(S)					
VOLUME	600	800	1504	3018	6026	13001
1	0	0	0	0	0	.0003
2	0	0	0	0	0	.0024
3	.0001	.0011	.0058	.0094	.0133	.0179
4	.0001	.0022	.0063	.0097	.0135	.0178
5	.0008	.0017	.0063	.0097	.0135	.0178
6	.0009	.0025	.0066	.0098	.0135	.0177
7	.0001	.0025	.0064	.0097	.0136	.0178
8	.0038	.0135	.0100	.0115	.0149	.0180
9	.0015	.0024	.0066	.0098	.0135	.0178
10	.0001	.0029	.0064	.0096	.0134	.0178
11	.0002	.0089	.0090	.0110	.0143	.0181
12	.0002	.0012	.0065	.0097	.0134	.0177
13	0	0	.0003	.0005	.0006	.0010
14	.0002	.0010	.0056	.0092	.0129	.0167
15	0	0	0	0	0	0

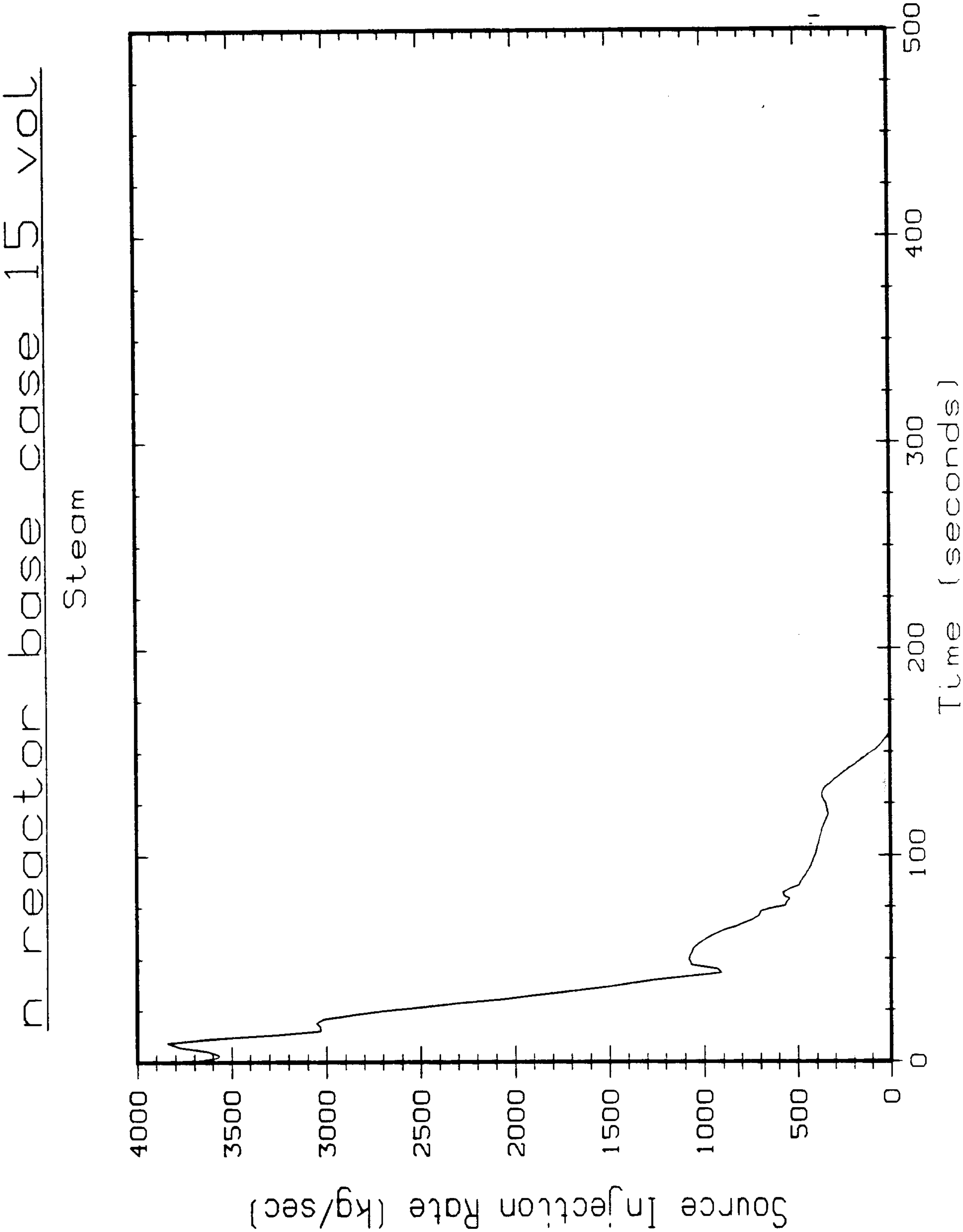


Figure 4.1a. Extended NUSAR Steam Source Rate

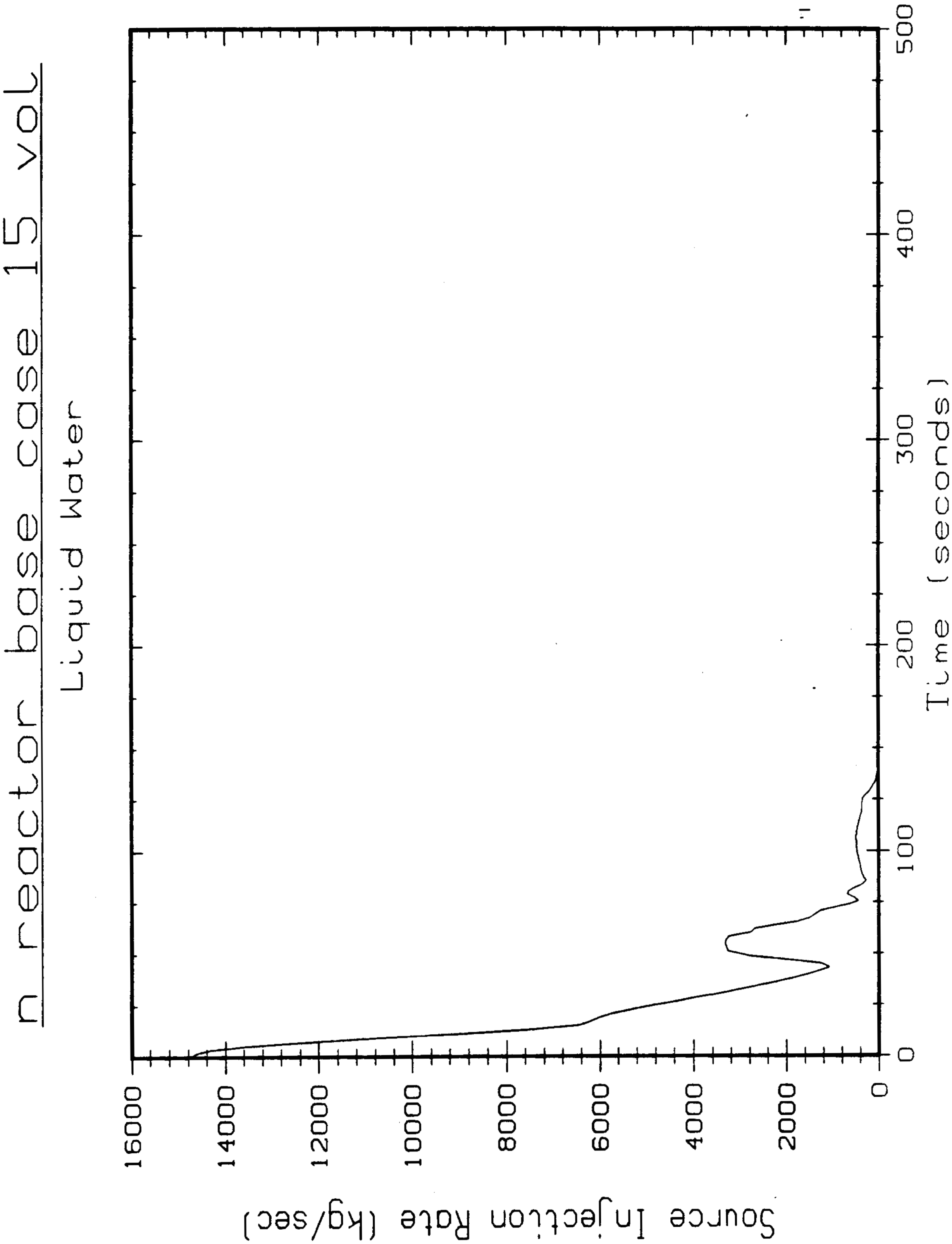


Figure 4.1b. Extended NUSAR Steam Source Rate (Cont.)

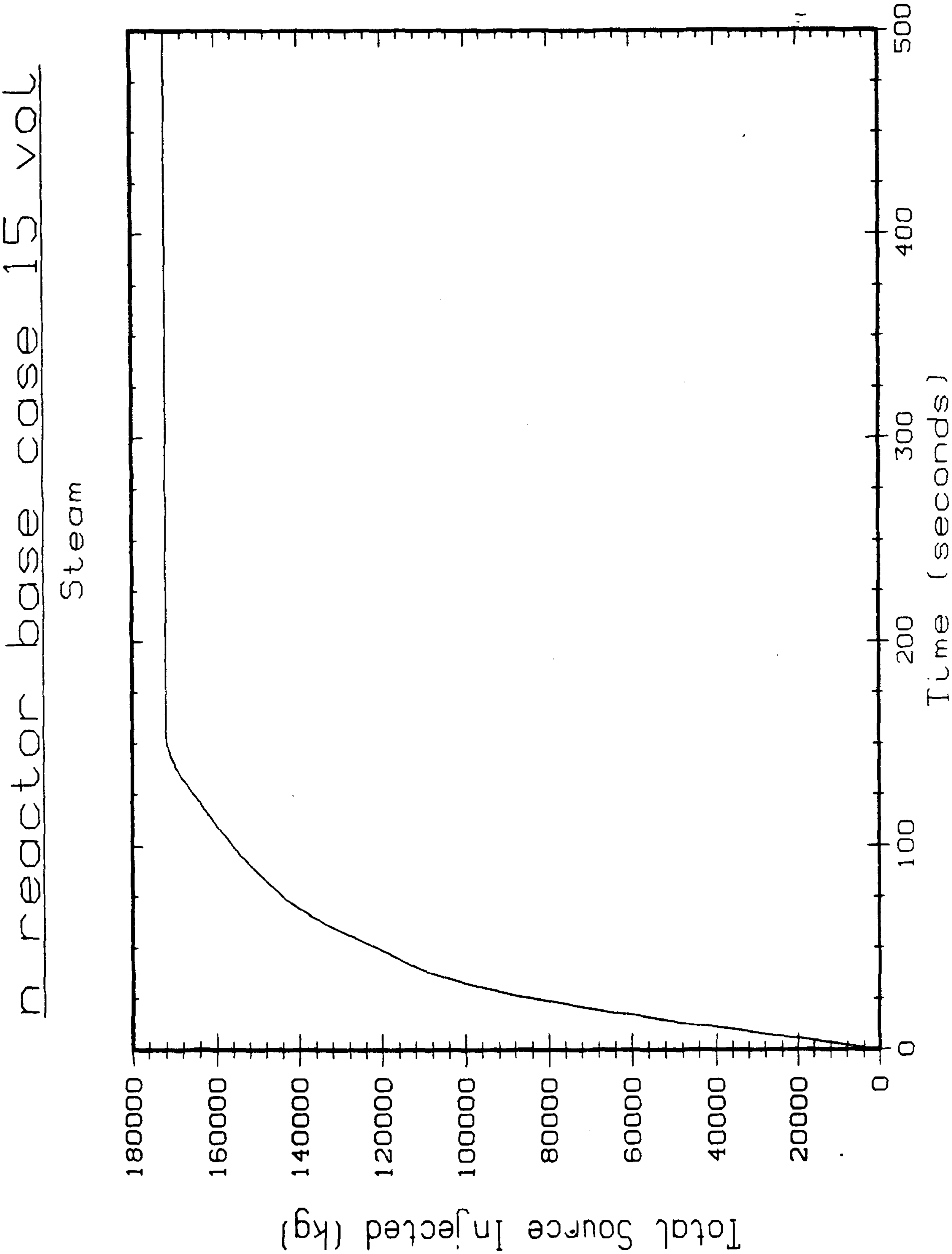


Figure 4.2a. Total Steam Injected

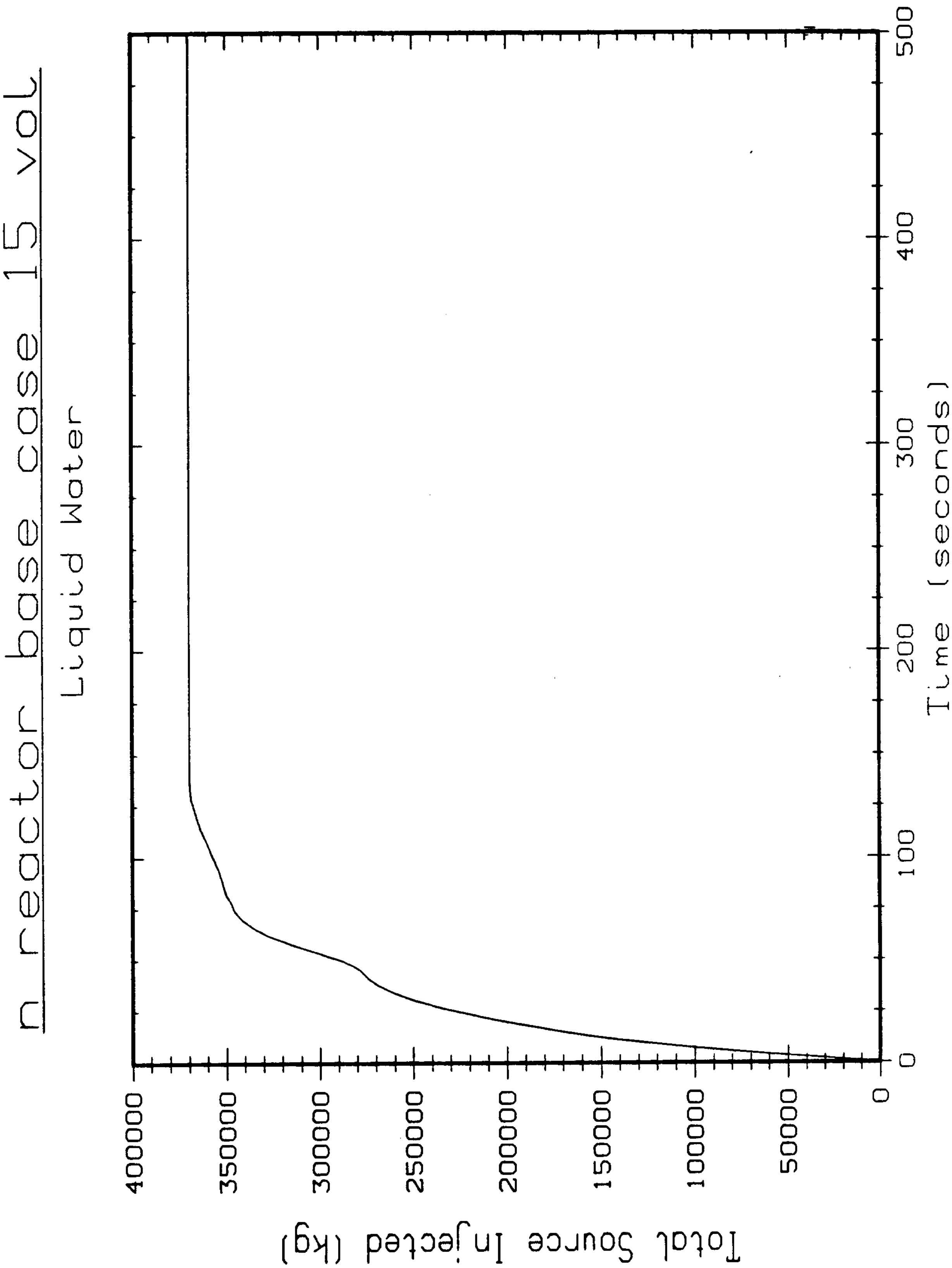


Figure 4.2b. Total Steam Injected (Cont.)

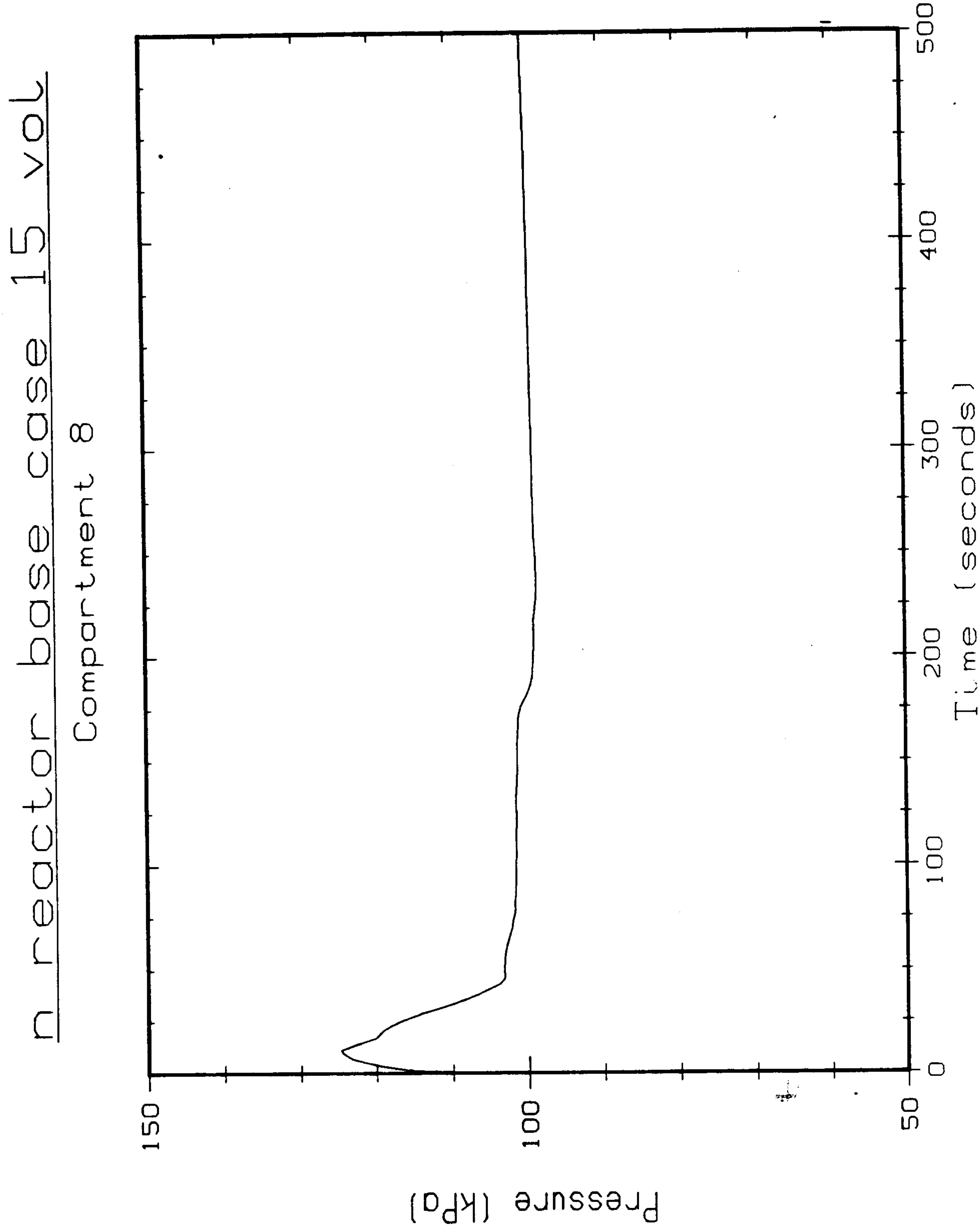


Figure 4.3. Case 1 Pressure in Volume 8 (500 s)

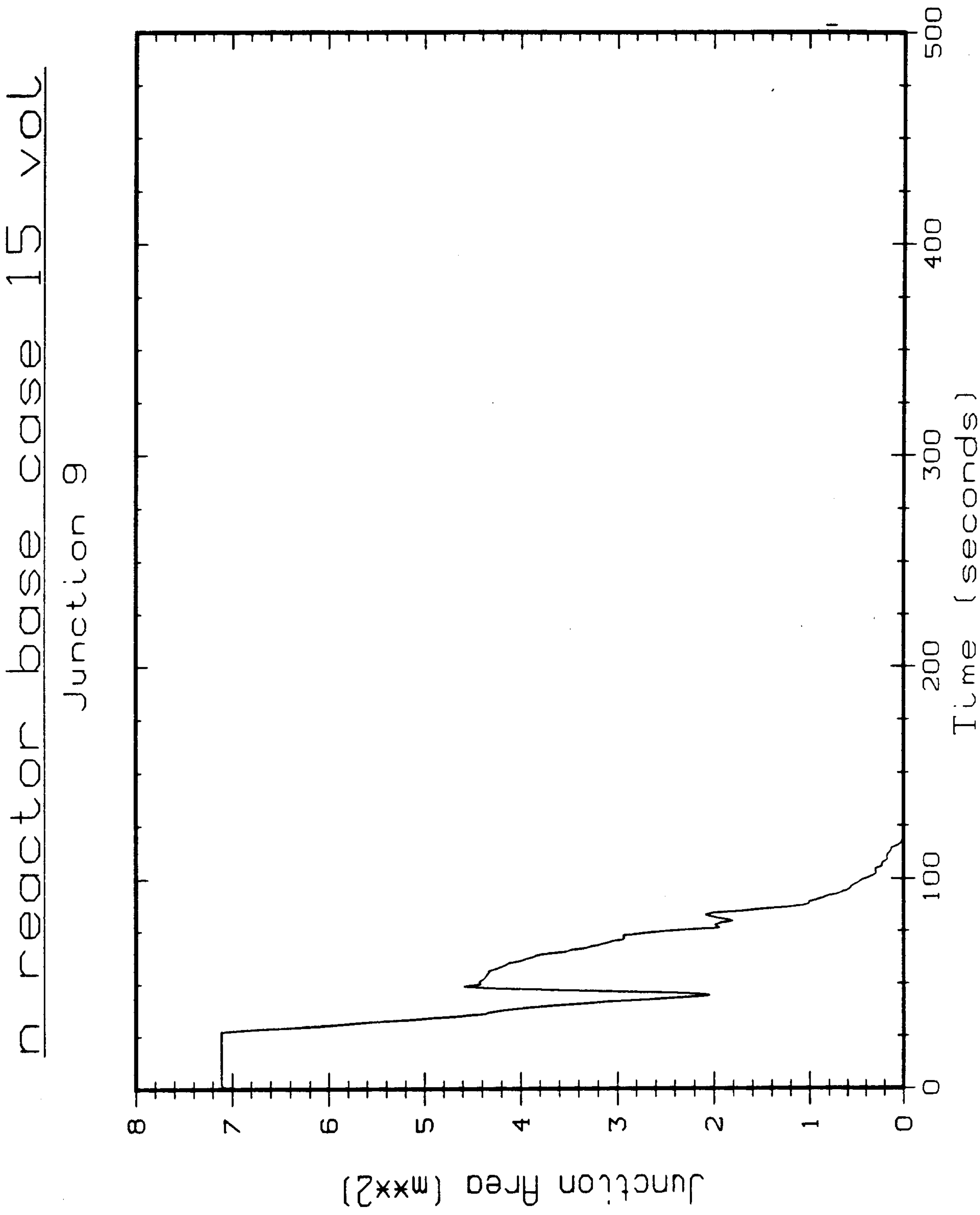


Figure 4.4. Case 1 105-109 Cross-Vent Area

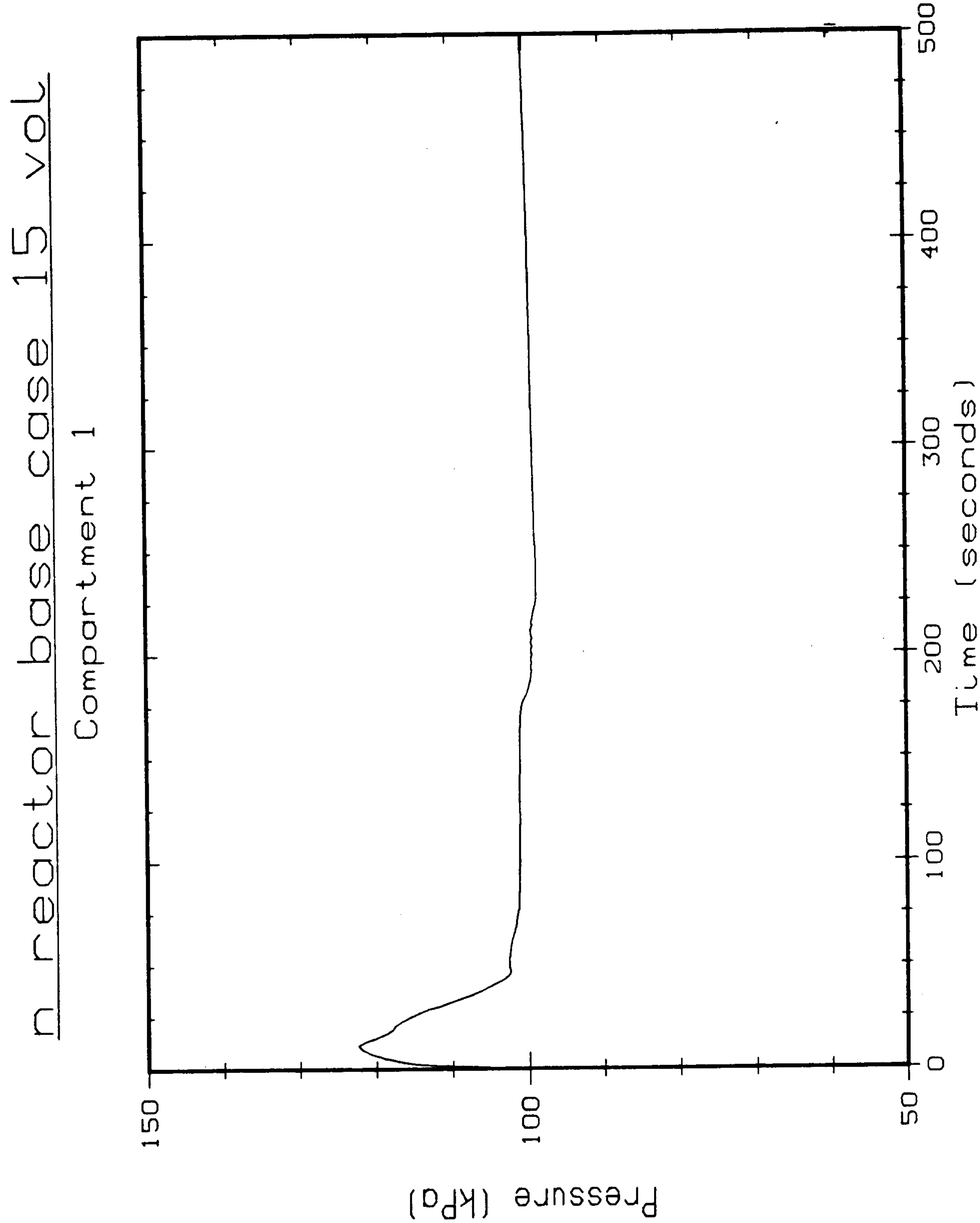


Figure 4.5. Case 1 Pressure in Volume 1 (500 s)

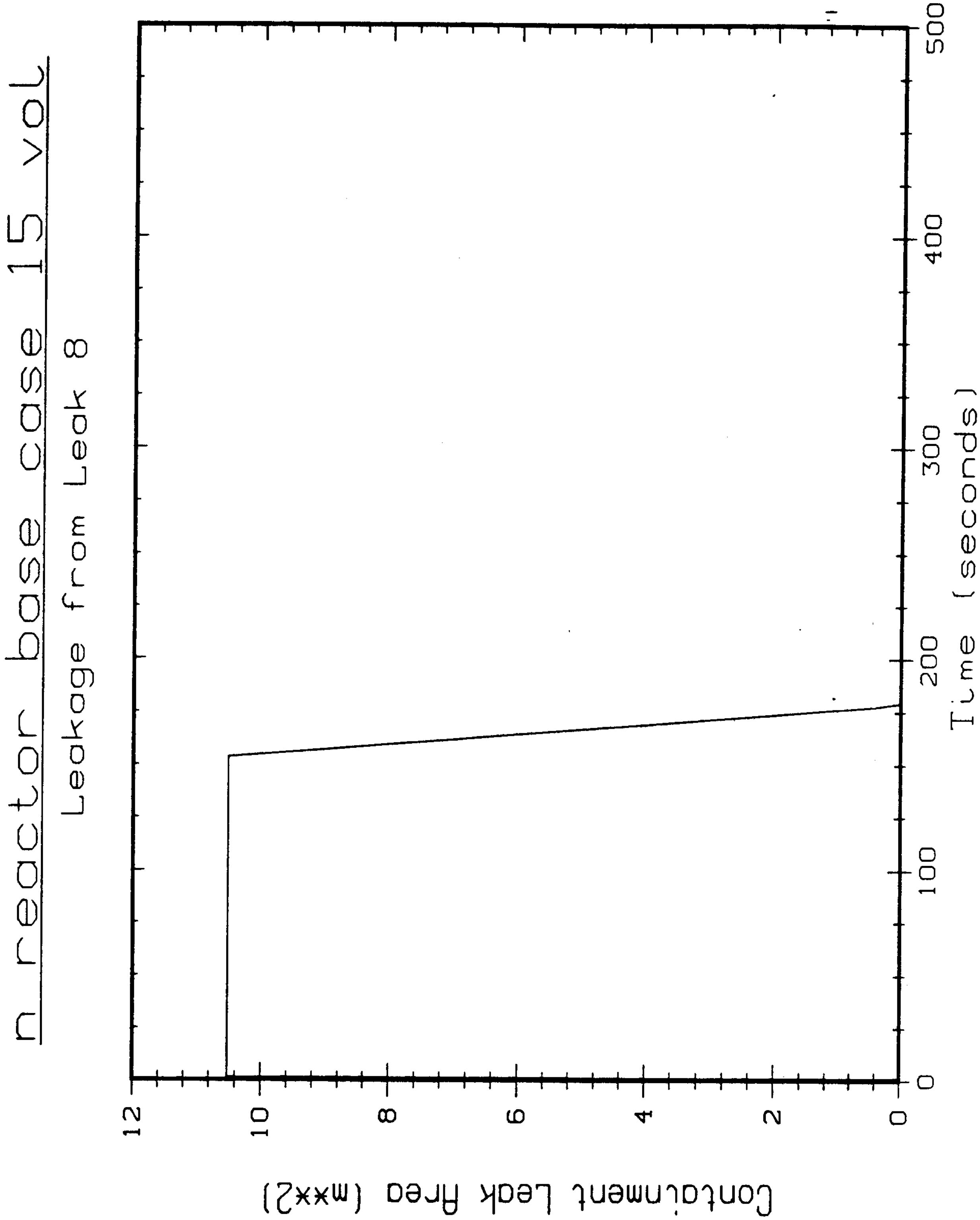


Figure 4.6. Case 1 Steam Vent Area in 109 (500 s)

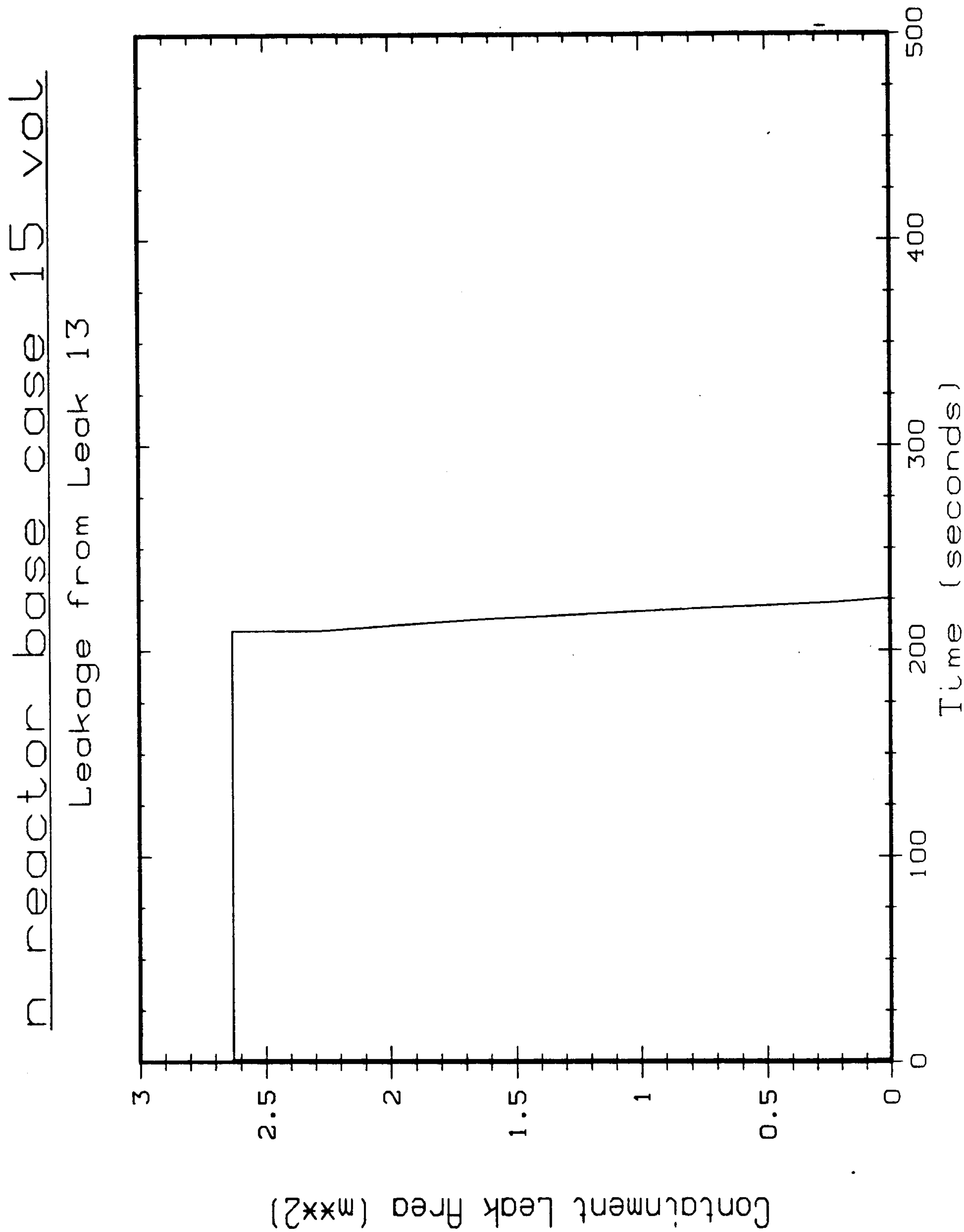


Figure 4.7. Case 1 Special Steam Vent Area in 105 (500 s)

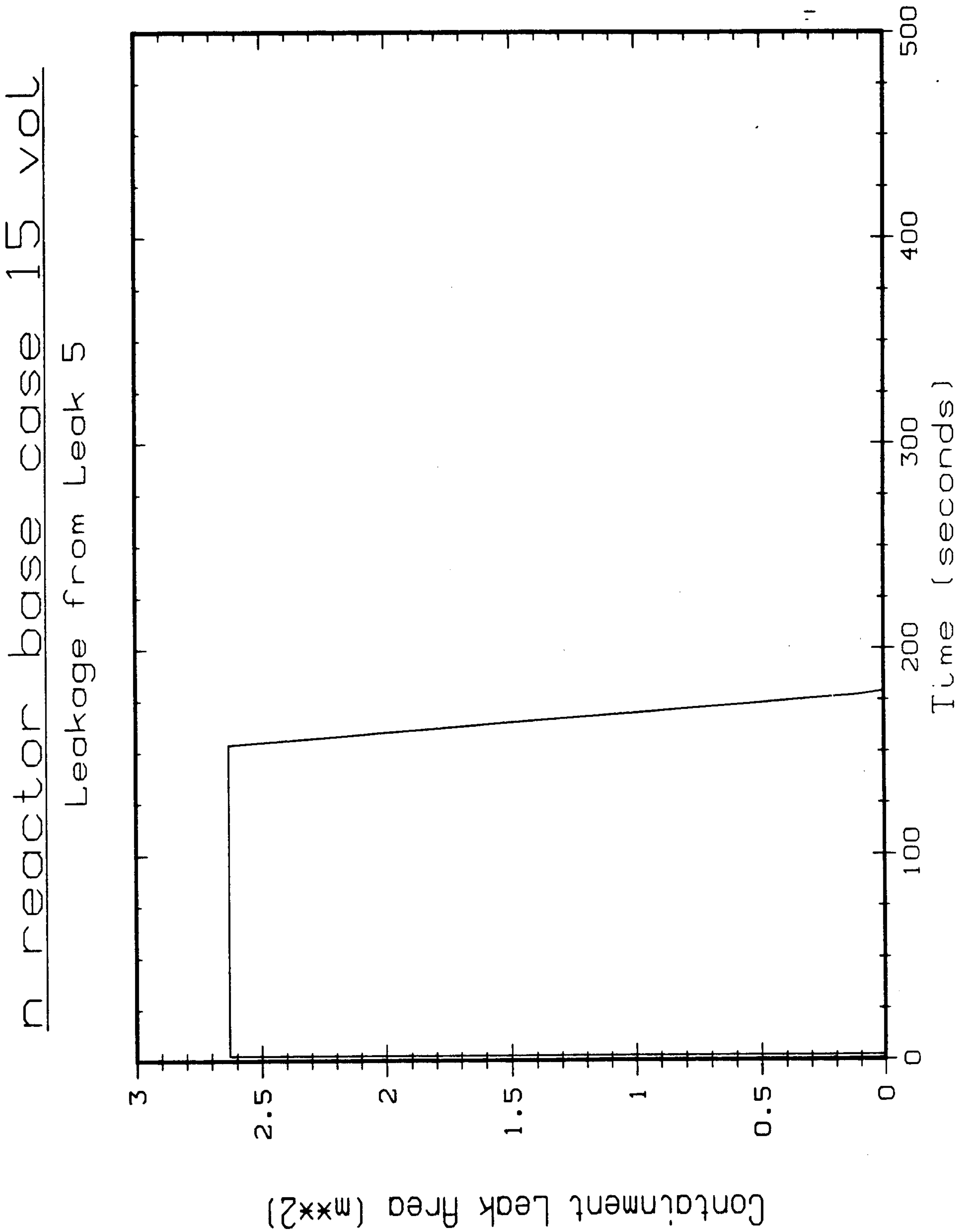


Figure 4.8. Case 1 Regular Steam Vent Area in 105 (500 s)

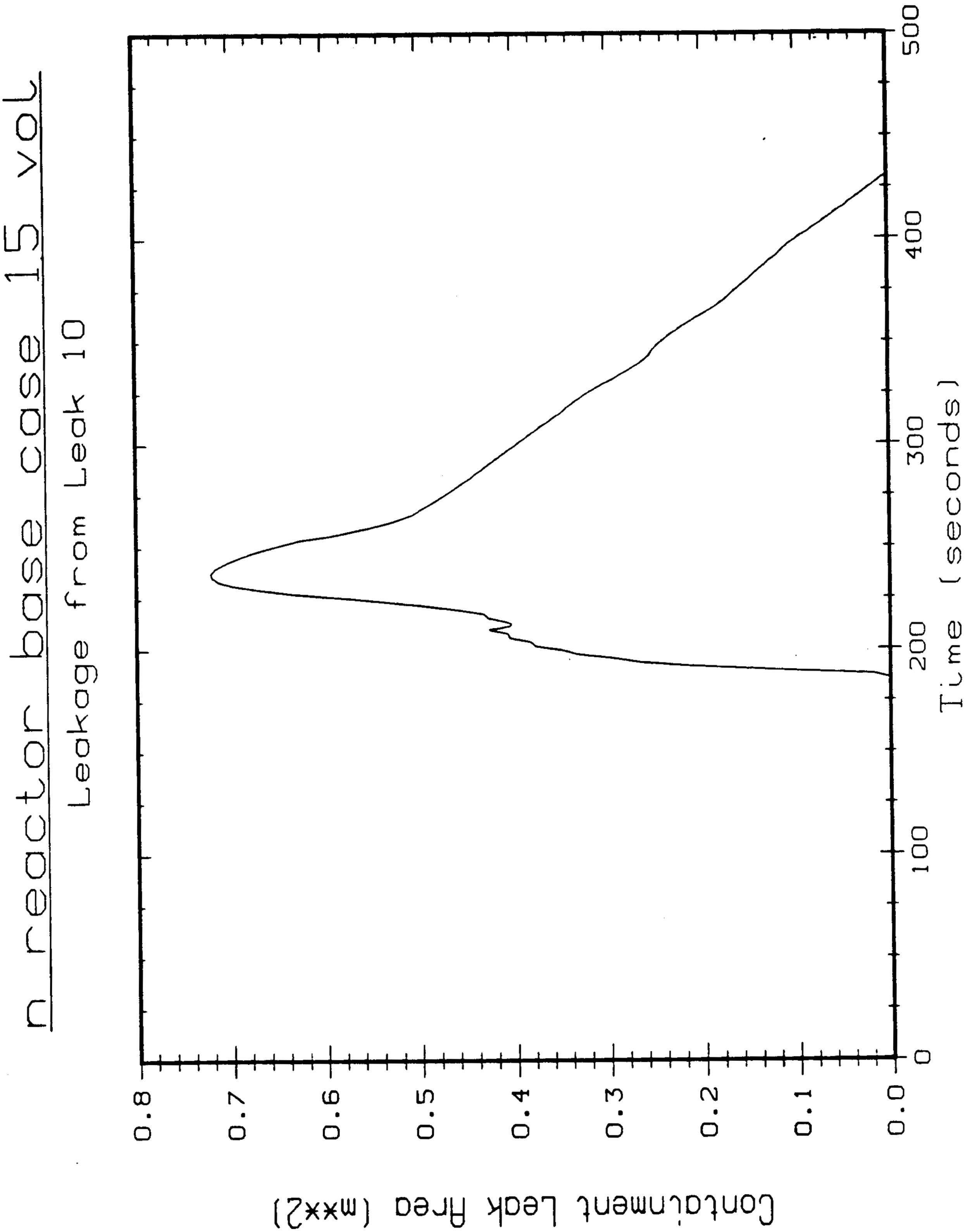


Figure 4.9. Case 1 Vacuum Breaker Area in 109 (500 s)

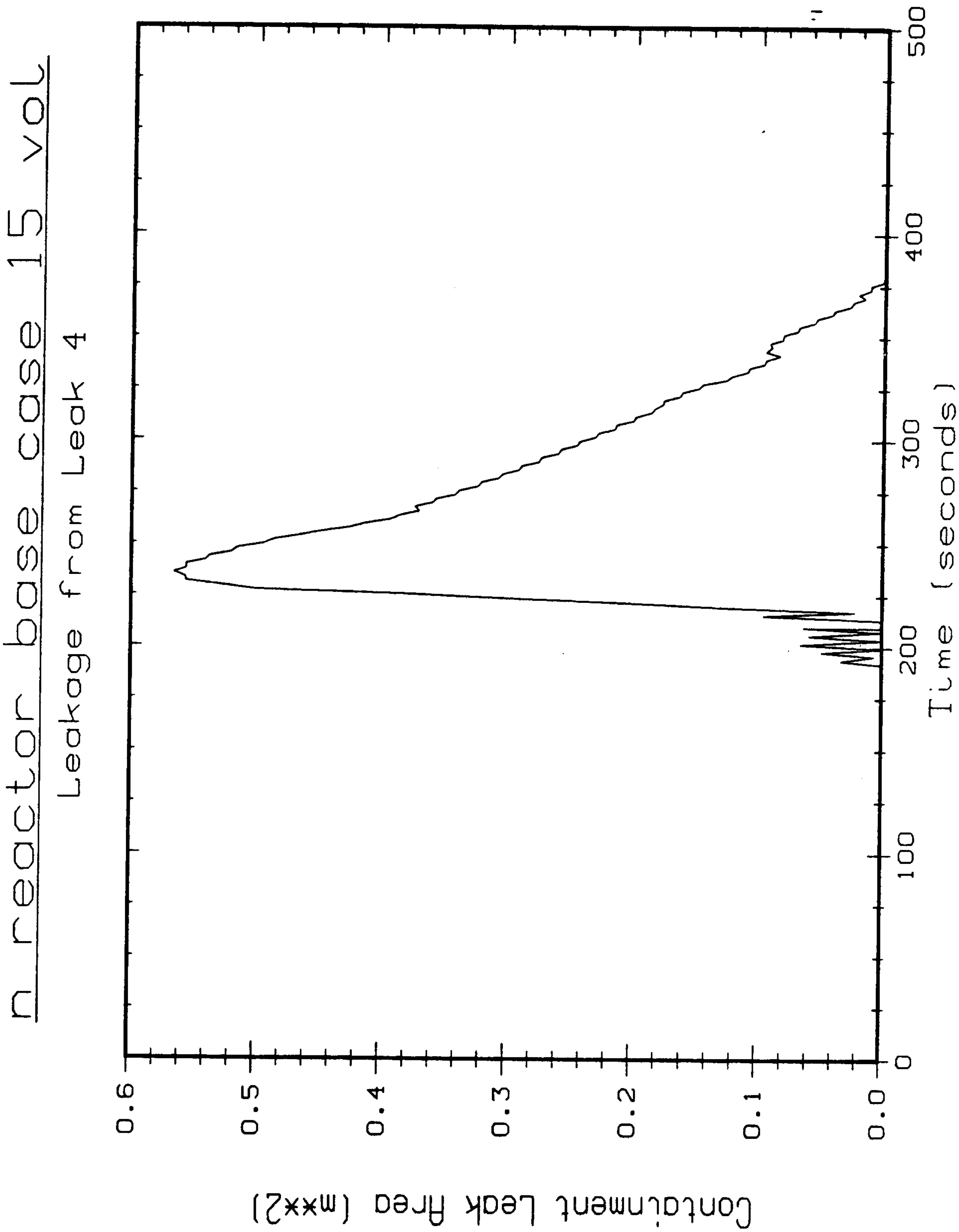


Figure 4.10. Case 1 Vacuum Breaker Area in 105 (500 s)

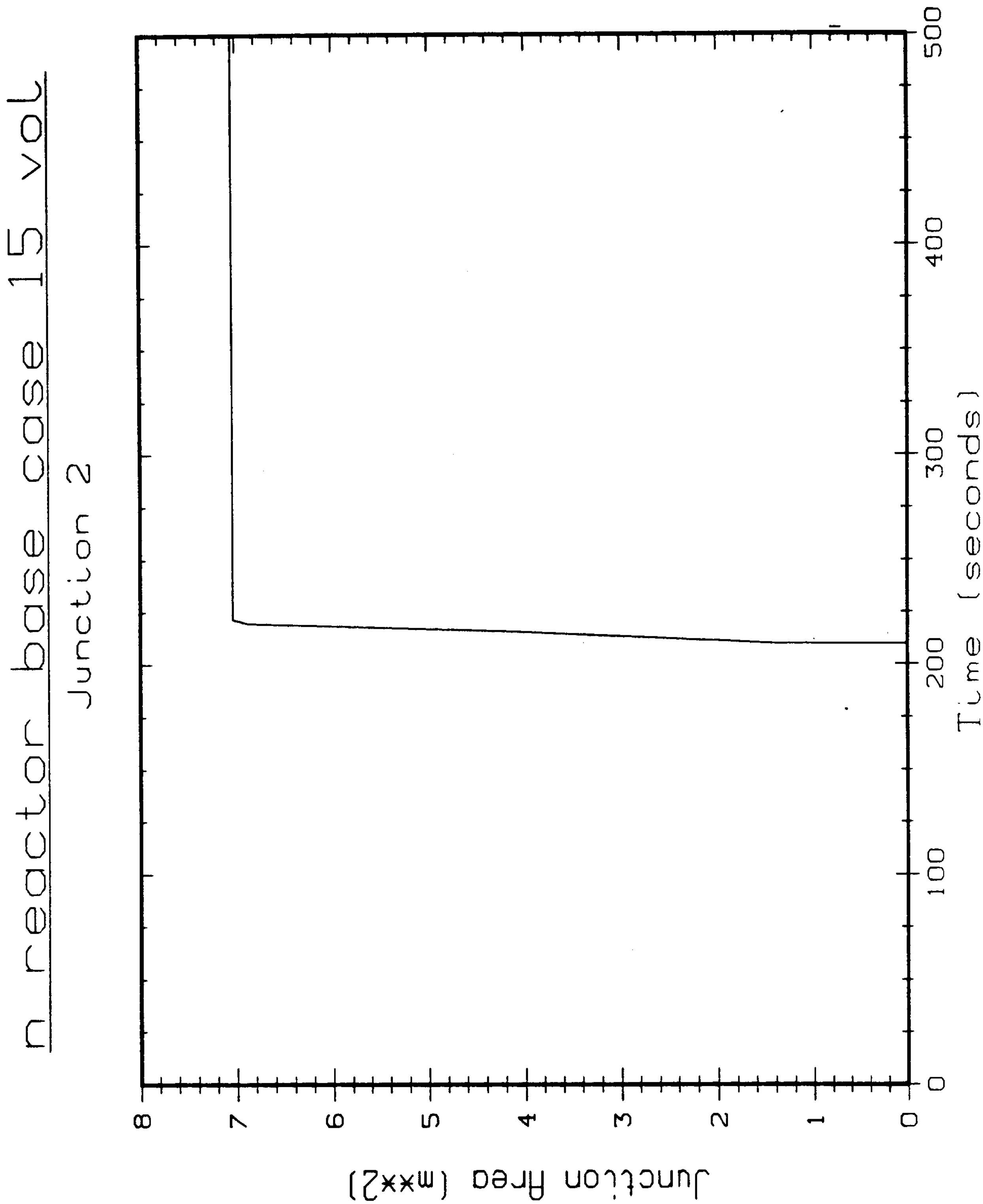


Figure 4.11. Case 1 Confinement Exhaust Valves Area (500 s)

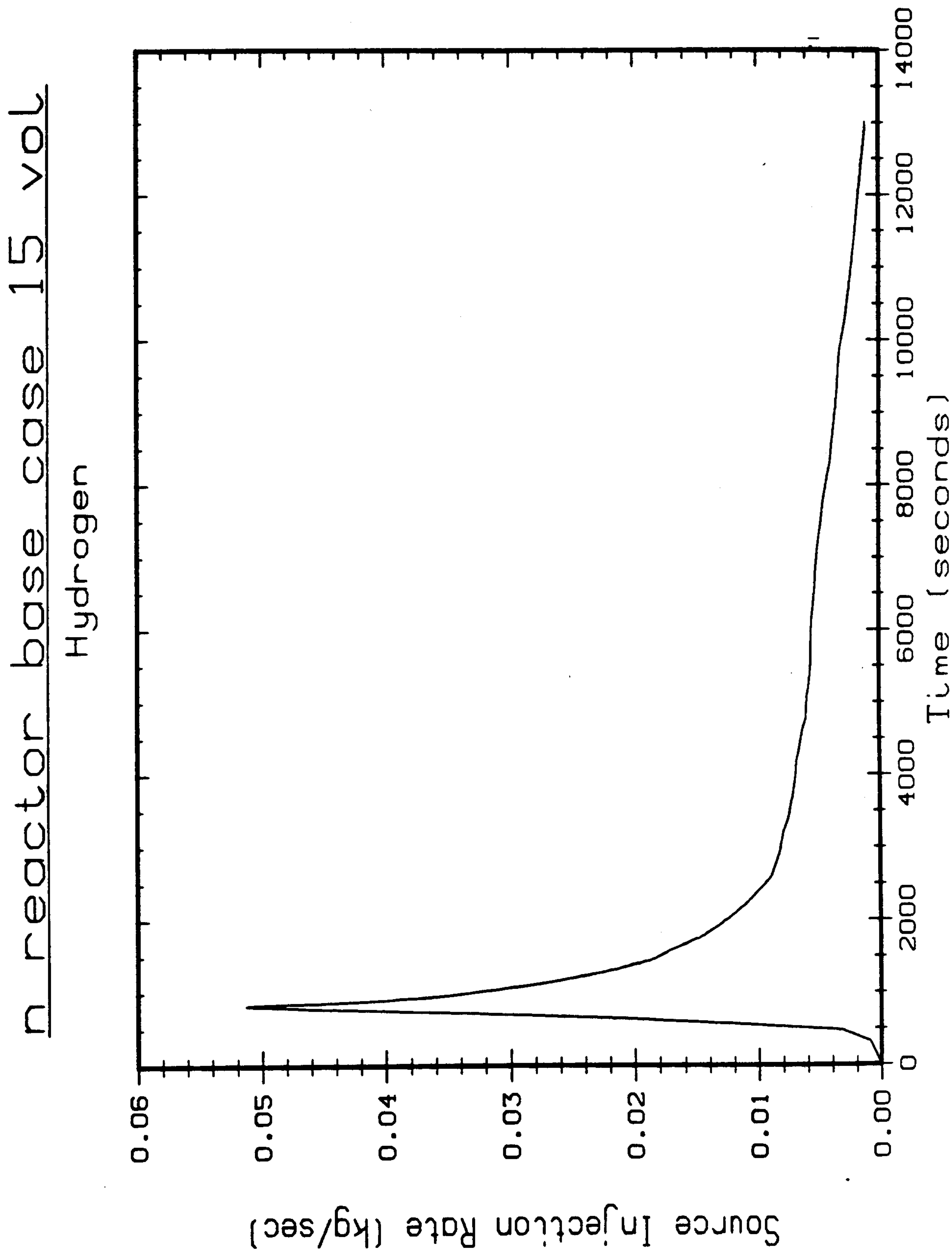


Figure 4.12. Extended NUSAR Hydrogen Source Rate

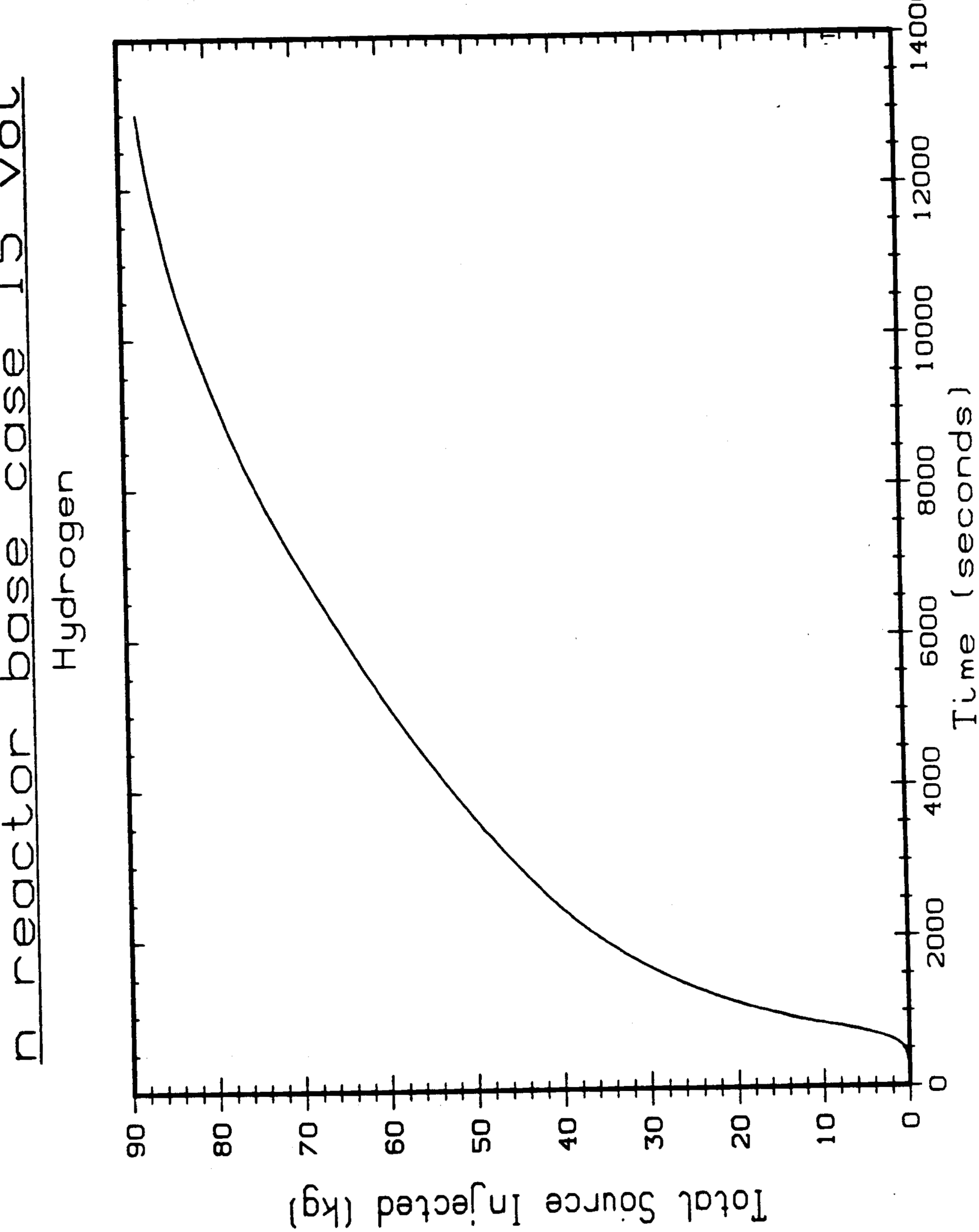


Figure 4.13. Total Hydrogen Injected

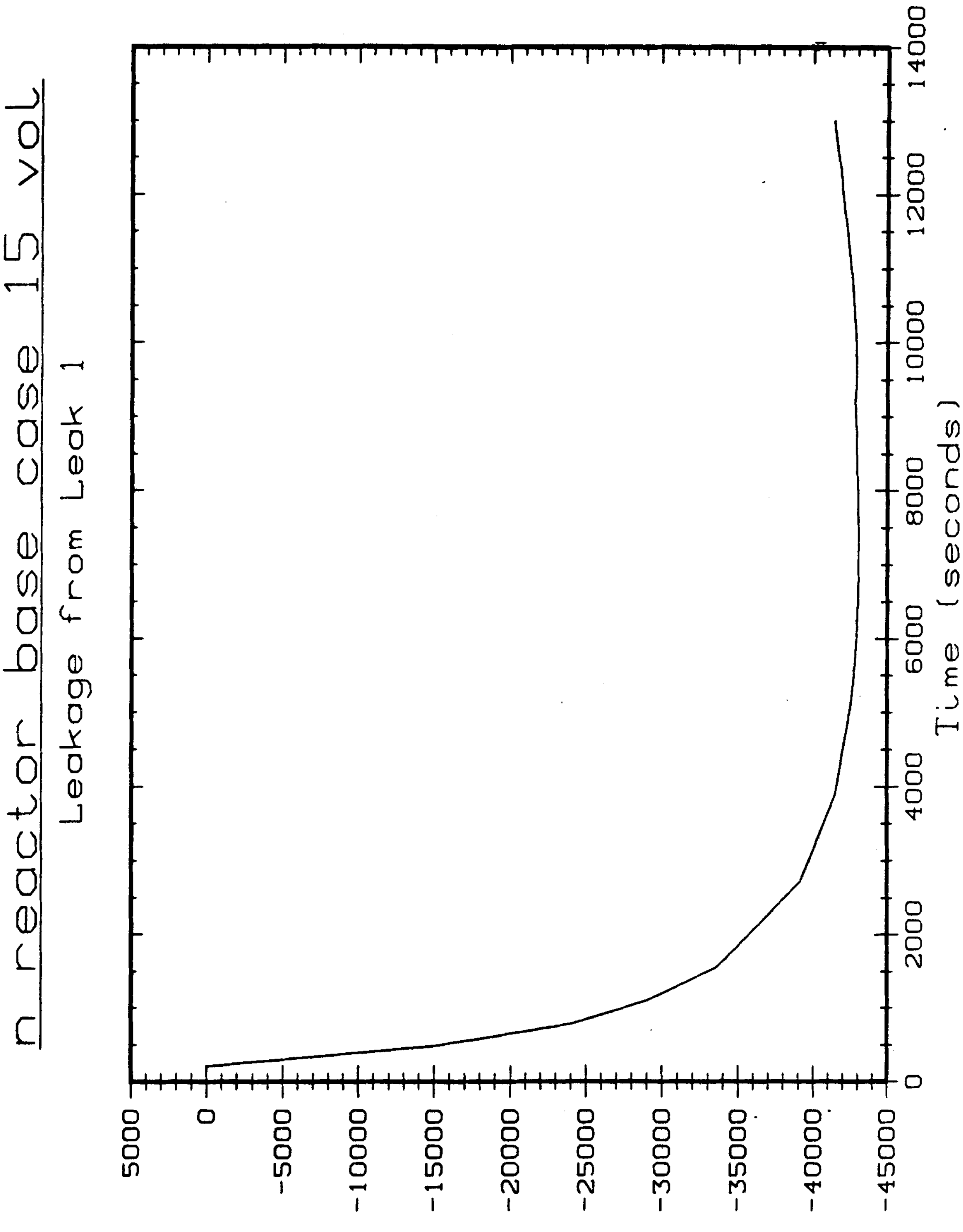


Figure 4.14. Case 1 Total Leakage from Filter Building

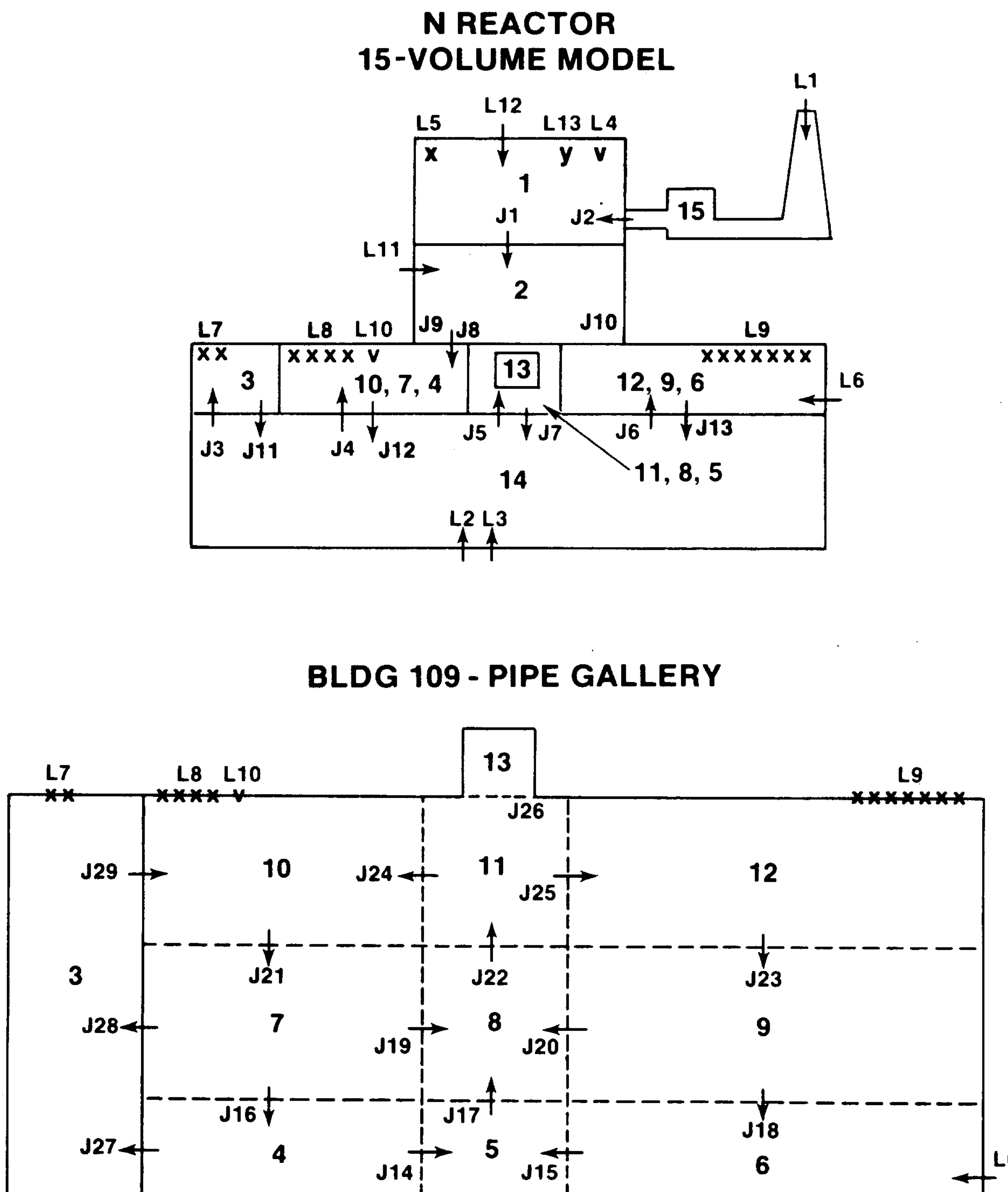
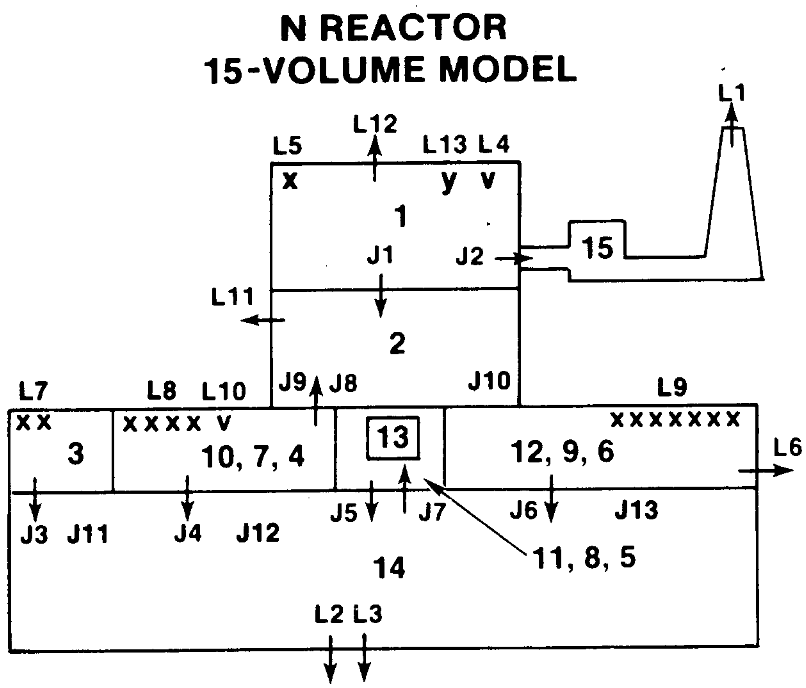


Figure 4.15. Gas Flow Pattern at t = 3000 s



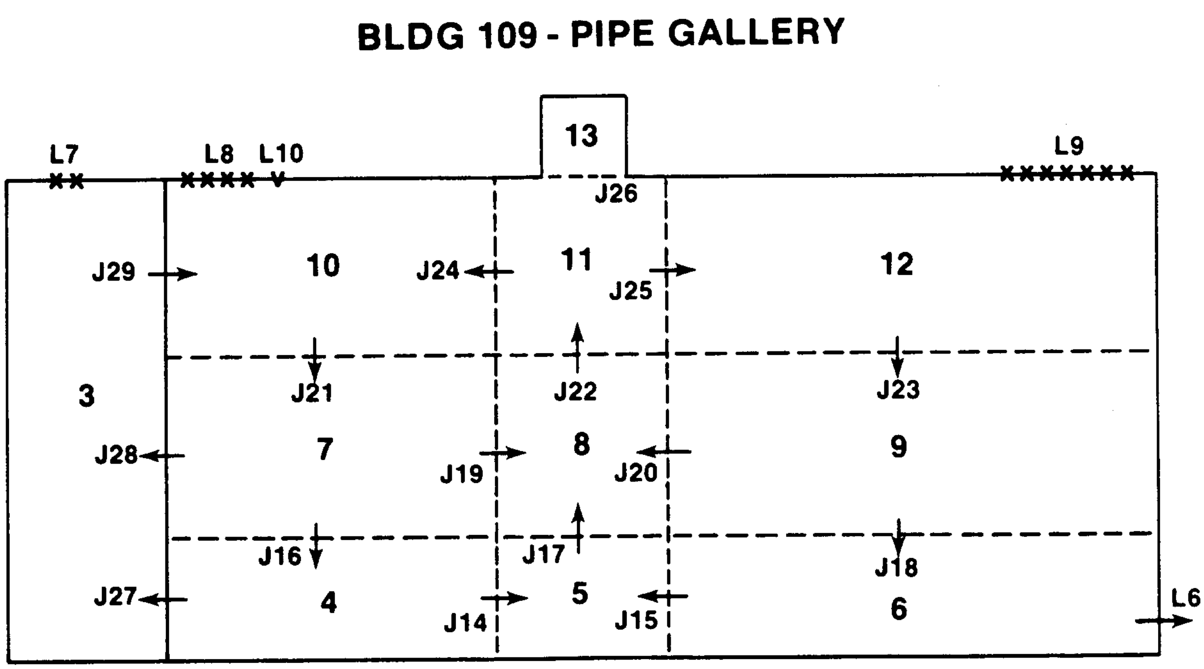


Figure 4.16. Gas Flow Patterns at t = 10,000 s

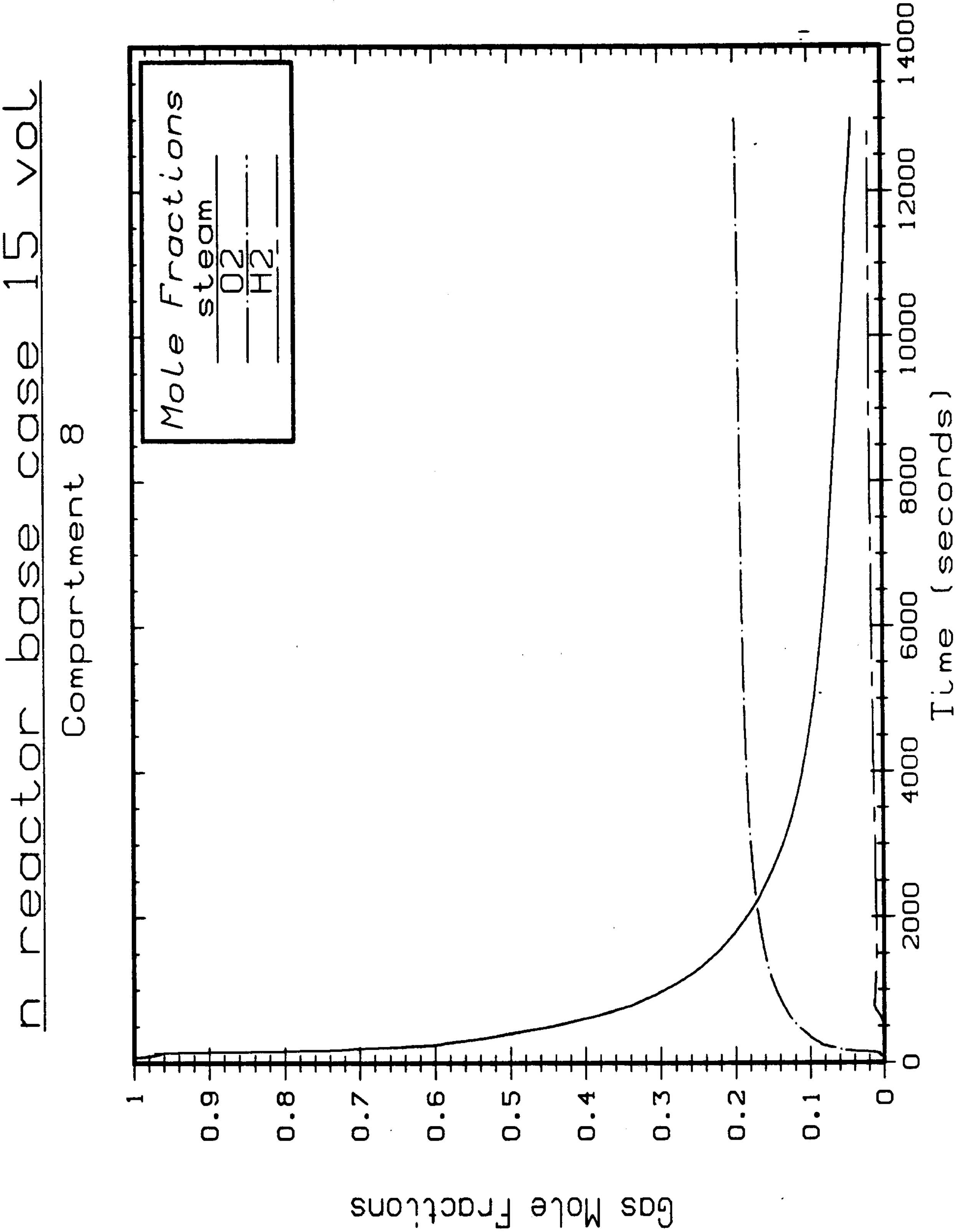


Figure 4.17. Case 1 Molar Concentrations for Volume 8

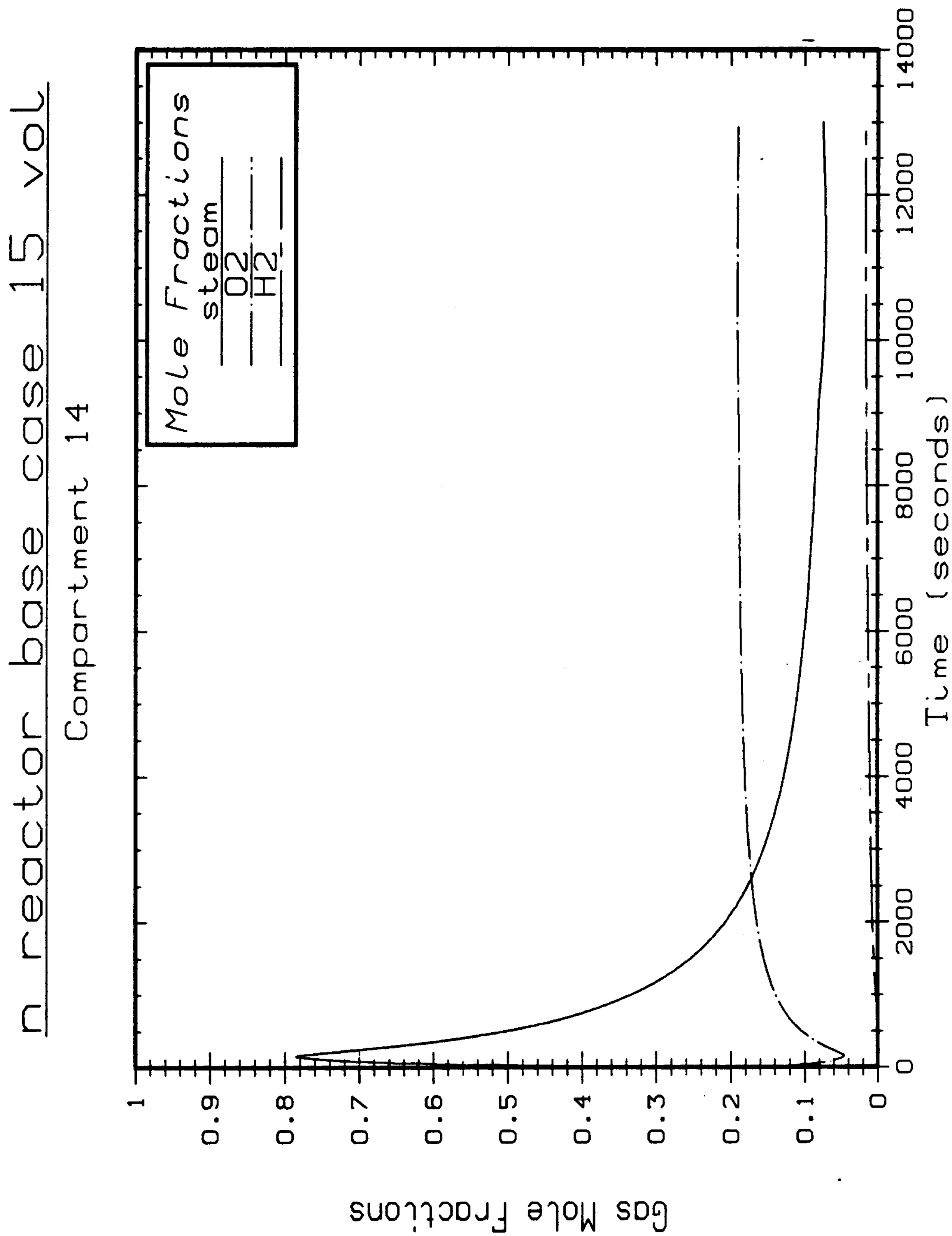


Figure 4.18. Case 1 Molar Concentrations for Volume 14

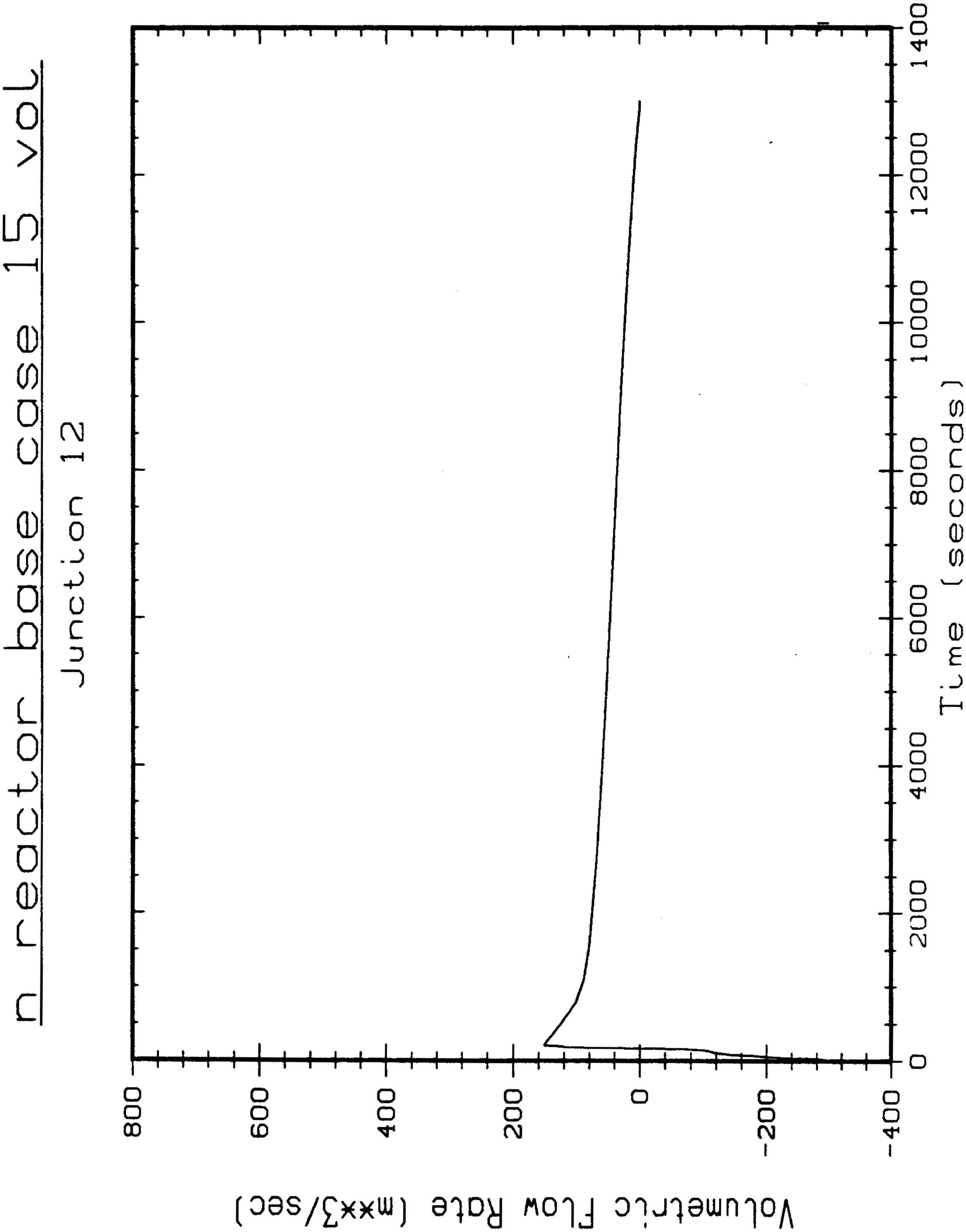


Figure 4.19. Case 1 Sump Junction to Steam Generator Cells

5. RESULTS FOR PARAMETRIC CALCULATIONS (CASES 2-9)

5.1 Introduction

As pointed out in Section 1, separate extensive efforts are underway to: 1) identify possible severe accident sequences, 2) characterize the progression of these accidents, and 3) predict the rate and quantity of hydrogen production. In order to obtain some preliminary information on hydrogen release scenarios, UNC asked Sandia to analyze variations of the hypothetical accident originally analyzed in their NUSAR.

In this chapter, we will describe the results of twelve parametric calculations done to investigate the effects of sprays (on/off), sump pumps (on/off), source location (pipe gallery, front pipe barrier space, pressurizer penthouse, and steam generator cells 4 and 6), source strength (twice NUSAR), and nodalization.

5.2 Case 2

Case 2 was an investigation of how changes in the hydrogen source term would affect overall hydrogen concentrations. For these calculations, the hydrogen source rate was selected to be twice the original NUSAR hypothetical accident.

The 15-volume model with the source at the cold leg manifold was used to analyze this case. Except for the doubled hydrogen rate, all other parameters were the same as in the base case.

5.2.1 The First 500 Seconds

Since the steam and water sources were unchanged, the confinement response was identical to the base case (Section 4.2) during the blowdown. At the end of 500 seconds, a filtered release configuration has been established (although flow is still into the building at that point) and confinement sprays are on.

5.2.2 Long-Term Behavior

Hydrogen production first becomes significant after the end of the blowdown at about t = 160 s. It peaks at t = 832 s and then declines out to t = 13,000 s, where the calculation ends. Figures 5.1 and 5.2 show the hydrogen source rate and integrated hydrogen injection, respectively.

As in the base case, for the first few hours flow is entering into the 105 building, from the filter building, and then entering into the 109 building, due mainly to steam condensation. Very little hydrogen is, therefore transported into the reactor building until late into the accident when, due to the source term and reduction in condensation, the flow reverses and a small outflow is established into the 105 building and then out through the filtered release path. This reverse flow begins at about t = 7,000 s, but significant hydrogen is not transported into the 105 building for some time. By the end of the calculation, no noticeable concentration of hydrogen has appeared in the filter building. This is an identical result to the base case.

The hydrogen transport in the 109 building is also similar to the base case, except for the larger quantity of hydrogen. By examining Table 5.1, one can see that significant differentials exist in the hydrogen concentrations in the pipe gallery and steam generator cells until the source term decreases sufficiently to allow the recirculation loops to mix the hydrogen relatively uniformly by about 3,000 s. After that, the concentrations remain uniform in the pipe gallery and steam generator and auxiliary cells until the end of the calculation. As before, not much mixing occurs between the pipe gallery and the pressurizer penthouse because it is a dead-ended volume. Figures 5.3 and 5.4 show the hydrogen concentrations in the source volume and steam generator cells, respectively. Table 5.1 shows the hydrogen concentrations at selected times for all volumes. No flammable mixtures occurred in any volume.

5.3 Case 3

Case 3 was the first case analyzed using the 38-volume model. We used the same source terms as in Case 2 (twice the NUSAR hypothetical accident for hydrogen). This case was run to determine what effects more detailed modeling would have on the hydrogen transport.

5.3.1 The First 500 Seconds

The initial part of the accident progressed almost identically to the 15-volume case. The peak pressure generated during the blowdown and the operation of all junctions and leaks were the same as in the first two cases except for the vacuum breakers. In this case, the vacuum breakers in the 105 building opened at t = 200 s instead of t = 183 s and both sets closed earlier (about t = 340 s instead of t = 380 s in the 105 building and at t = 380 s instead of t = 430 s in the 109 building). The blowout hatches on top of the pipe barrier spaces open at t = 90 s because of the way heating from the front and rear reactor faces was modeled. These hatches are not modeled in the 15-volume case, and made little difference in this case.

5.3.2 Long-Term Behavior

The transport of hydrogen in the pipe gallery and steam generator and auxiliary cells was almost identical to Case 2.

By the end of the run, the hydrogen concentration is virtually uniform in the whole 109 building, except of course for the pressurizer penthouse where there is little mixing. This shows that the effect of lumping the steam generator and auxiliary cells into one volume is not very large and that the vertical circulation through the sumps and ducts dominates the mixing from the pipe gallery to the cells.

Because of the finer nodalization in the reactor building, circulation patterns are set up which promoted more mixing than in the 15-volume model, where there were only two volumes. The hydrogen does not begin to get into the reactor building until flow reverses at around 7,000 s and the amount of hydrogen transported into the 105 building remains small. The concentrations in the rear volumes where the hydrogen first enters are slightly higher than in the front. Some hydrogen is beginning to leave the confinement through the filtered release path earlier than in Case 2 due to this more vigorous mixing.

Table 5.2 shows the hydrogen concentrations at selected times for all 38 volumes. No flammable mixtures occurred anywhere in confinement.

5.4 Case 4

For Case 4, the source location was moved to the front pipe barrier space (Volume 16). Case 4 and all subsequent cases except Case 10 also use the 38-volume model. The steam and hydrogen source rates were the same as used in Case 1 (i.e., the extended NUSAR hypothetical accident). For this particular location, the steam rate, which is for a large break, is probably inappropriate since there are not any pipes this large in the pipe barrier space. This source will be conservative in its predictions of peak pressure during the blowdown. Since accidents at this location have not yet been analyzed, it is difficult to tell if this would be conservative for the hydrogen rate.

We reached a temporarily flammable mixture in the source compartment in this case. A second run was performed in which we burned the hydrogen when it reached its peak concentration (Case 4b) at 1000 s.

5.4.1 The First 500 Seconds

By comparing Figures 5.5 and 5.6, we see that within the 105 building, the pressure exceeds 2.0 psig (115.1 kPa) before pressure in the 109 building even reaches 1.5" wg (101.7 kPa). The hatches on the pipe barrier space blow out almost immediately. At t = 0.1 s the pressure is 2" wg (101.8 kPa) and the 105 building isolates and the confiner circuit timers are actuated. At t = 0.18 s, the 105 sprays are actuated at 10" wg (103.8 kPa) (flow starts at t = 44.18 s). At t = 0.33 s, the special steam vent blows open at 1.25 psig (109.9 kPa) and at t = 0.48 s, the regular 105 steam vent blows open at 2.0 psig (115.1 kPa) . At t = 0.568 s, the closed cross-vents to the 109 building blow out at 2.25 psid (15.5 kPad). Lagging the 105 building, at t = 0.7 s the 109 building isolates at 2" wg (101.8 kPa) . The 109 sprays actuate at 10" wg (103.8 kPa) at t = 1.05 s (flow begins at 45.059 s). The regular 109 steam vents blow open at 2.0 psig (115.1 kPa) at t = 3.93 s.

Because the cross-vents and steam vents were not designed to handle such a conservative steam source as this, at about t = 10 s the pressure increases up to 7.0 psig (149.6 kPa) in the reactor building while remaining below 2.3 psig (117.2 kPa) in the pipe gallery. After this, the pressure subsides, due to continued venting, and later, as a result of condensation and sprays, goes below atmospheric. The vacuum breakers open at about t = 192 s and reclose at about t = 420 s when the filter building flow (vent opened at t = 205 s) is sufficient to maintain pressure by itself. As in the other cases, the regular steam vents reclosed at about t = 150 s and the special steam vent at t = 205 s when the filter vents opened.

As discussed above, the blowdown rate is very conservative. In addition to reaching 7.0 psig (149.6 kPa) in the reactor building as a whole, the pressure in the pipe barrier space peaked at 9.9 psig (169.6 kPa) (Figure 5.7). A smaller pipe break size would lead to a smaller but longer blowdown which would result in smaller peak pressures. Also, we did not model the banana wall which would begin to relieve pressure above the confinement design pressure of 5 psig (136 kPa).

5.4.2 Long-Term Behavior

As in the previous cases, hydrogen injection becomes significant at t = 160 s. The source peaks at t = 832 s and decreases after that. The hydrogen concentration peaks out in the pipe barrier space at 6.5% at t = 1000 s. After this, the concentration decreases and then begins a very slow rise to the end of the calculation at t = 10,000 s.

There are large flow loops set up in the reactor building which mix the hydrogen very well outside of the pipe barrier space, although the concentrations are slightly higher in the rear than in the front. When the steam vents close at t = 150s, the 109 building becomes a dead-ended volume but, due to the steam condensation and the cross-vents, some hydrogen is transported into the building. This flow is larger than in the previous case where the source was in the pipe gallery and there was little interchange with the 105 building until late in the calculation. Because all eight cross vents are blown open, more recirculation occurs. Concentrations in the 109 building remain about one-tenth of those in the 105 building, but the building is fairly well mixed after about 3,000 s.

Flow is in through the filter vent until about 7,000 s, but after that, a very small positive outflow is established (Figure 5.8). Table 5.3 shows the hydrogen concentrations at selected times for all volumes.

5.4.3 The Hydrogen Burn (Case 4b)

This run was identical to the original Case 4 except that a burn was initiated in the source compartment (volume 16) at t = 1,000 s when hydrogen concentration peaked at 6.5% (Figure 5.9). The amount of hydrogen burned was about 3kg and the burn did not propagate to any other volume. Almost no pressure spike was observed anywhere in confinement due to the small amount burned (Figures 5.10 and 5.11), and the pressure relief to the other compartments. The pressure relief occurs because the burn is relatively long for the compartment involved (12 s). The temperature transient was more severe (Figure 5.12 and Figure 5.13). A small flow out through the filter building occurs for about 30 s and then the hydrogen concentration in the source compartment begins increasing again. The concentration may reach flammable limits again, but the result would be much the same.

5.5 Case 5

In Case 5, the source was located in the pressurizer penthouse on top of the 109 building. Both the steam and hydrogen sources are the extended NUSAR hypothetical accident sources used in the base case.

5.5.1 The First 500 Seconds (Case 5)

In general, the pressure response and the operation of all the junctions and vents were the same as in the base case. The peak blowdown pressure was slightly higher (126.0 vs. 124.7 kPa) due to the smaller volume into which the source was injected.

5.5.2 Long-Term Behavior (Case 5).

As can be seen in Figure 5.14, the initial blowdown clears the penthouse volume of oxygen. Later, as the steam begins to condense, a small amount of oxygen is drawn back in from the pipe gallery. The hydrogen source, however, is sufficient to replace the steam condensed and the oxygen concentration peaks out at less than 3.5% before decreasing back to 2% for the rest of the calculation. The hydrogen concentration in the penthouse increases rapidly, reaching 10% at about 800 s, 50% at about 3,000 s, and 70% at the end of the calculation. For much of the calculations, the hydrogen would be at detonable concentrations except for the fact that the volume is initially steam inert and later oxygen inert.

Outside of the penthouse in the rest of the 109 building, the hydrogen is well mixed because of the flows generated by about 1,500 s. The final concentrations are much less than in the base case (about one eighteenth of the base case) everywhere except for the penthouse because the hydrogen is trapped there. Almost no hydrogen is transported into the reactor building until very late in the calculation when trace amounts are just beginning to appear. Table 5.4 shows the hydrogen concentrations at selected times for all volumes.

One must be very careful in drawing conclusions from this case. We know that, because the penthouse is a high, dead-ended volume into which we are injecting hot hydrogen, we should expect higher concentrations here than elsewhere in the pipe gallery. However, the junction linking the penthouse to the rest of the pipe gallery is modeled in HECTR as a single two-way flow junction. HECTR will only model flow in one direction at a time in a junction so, even if this is a fairly large junction (all of the bottom of the penthouse, 28' x 35'), no circulation will occur. As long as the hydrogen source is not sufficiently larger than the condensation rate, hydrogen will accumulate in the penthouse. Because of condensation and any recirculation which could be expected to occur, some oxygen might be expected to reenter the penthouse. No sprays exist in the penthouse (they are only in the main pipe gallery) to help promote mixing with the rest of the pipe gallery. Depending on rates of mixing, we have the possibility of local burns or even detonations in small or large portions of the penthouse volume. Some future calculations are planned, using a more detailed nodalization, to compare with COBRA-NC calculations.

5.6 Case 6 (6S, 6NS, 6B)

For Case 6, the postulated accident was assumed to occur in steam generator cell 6 (volume 30). The extended NUSAR hypothetical source was used as in the base case. A steam generator cell was chosen because the limited volume and flow paths to the rest of the 109 building could result in significant hydrogen buildup in the cell. Cell 6 was chosen because the wall separating the extension from the main pipe gallery would also affect circulation patterns.

Two cases were originally chosen. In Case 6S, the sump pumps would operate as designed and pump down the cell sump after the initial blowdown, reestablishing gas circulation through the sump. In Case 6NS, the sump pumps would not operate and the blowdown would block the sump. For Case 6NS, flammable concentrations of hydrogen were formed in the source cell and a burn calculation was performed (Case 6B).

5.6.1 Case 6S

In this case, two sumps were modeled: the first was the sump for cell 6 only, and the second was the sumps for the other five cells. The blowdown would completely fill the sump for cell 6 and partially fill the other sumps. The spray was apportioned to fall into the correct sump.

5.6.1.1 The First 500 Seconds

The pressure transient was similar to that of the base case (Figure 5.15), except that the peak pressure generated in the steam generator cell was higher (129.1 kPa vs. 124.7 kPa) due to the smaller volume into which the source was initially injected and the restrictive flow junctions to the pipe gallery. Except for the sumps, all other junctions and vents operate as in the base case. The sump for cell 6 fills almost immediately and the sump pumps start and remove 300 gpm. The other sumps fill about to the one-third level and their pumps also start.

5.6.1.2 Long-Term Behavior

After the blowdown, a condensation-induced flow in through the filter and 105 buildings is established, as in the base case. This condensation and inflow inhibits the flow from the cell and a peak in the hydrogen concentration occurs at about 3.6% at 1,200 s in cell 6 (Figure 5.16). After this, the sump reopens (Figure 5.17) slowly due to the pumps in time to create sufficient circulation to transport the hydrogen into the rest of the 109 building. The hydrogen first mixes uniformly in the pipe gallery (about 3,000 s.) and then later in the other steam generator and auxiliary cells (by the end of the calculation at 10,000 s). Very little hydrogen is transported into the reactor building until flow reverses late into the accident. Table 5.5 shows the hydrogen concentrations at select times for all the volumes.

5.6.2 Cases 6NS and 6B

These cases are identical to Case 6S except that the sump pumps do not operate. This means that the sump for cell 6 fills initially and does not reopen.

5.6.2.1 The First 500 Seconds (Cases 6S and 6B)

The first 500 seconds are identical to Case 6S except for the cell 6 sump being full.

5.6.2.2 Long-Term Behavior

The effect of the sumps is dramatic and shows up clearly in Figure 5.18. The steam condensation in cell 6 draws oxygen back into the cell, and this keeps the hydrogen in the cell. The lack of any flow through the full sump prevents circulation flow from developing, and the hydrogen concentration increases monotonically reaching 17% at 9,000 s. (As mentioned previously, preliminary COBRA-NC results show that the modeling of the large ducts may not be adequate in this case and a more detailed 65-volume model was constructed and used in case 10.) Some hydrogen is then beginning to enter the pipe gallery as the source compensates for the reduced condensation, creating an outflow from cell 6. At this time, the mixture is flammable and is close to detonatable.

In Case 6B, we initiated a burn at 9,000 s which lasted about 12 seconds (very slow due to the high steam concentration). The peak pressure was about 117 kPa (Figure 5.19), which was less than the peak during the blowdown (129.1 kPa). The temperature, however, reached 1212 K (Figure 5.20). This burn pushed sufficient hydrogen into volume 19 to allow the burn to propagate into that volume. The pressure in this compartment also peaked at 117 kPa and the temperature reached 1193 K. During the burn, the filter building confinement exhaust valves closed when the pressure exceeded 15" wg (105 kPa) and then reopened when the pressure dropped below 3" wg (102 kPa) as shown in Figure 5.21.

After the burn, hydrogen has been pushed into both the 105 and 109 buildings and is uniformly mixed in each building with the concentration in the 105 building (.18%) about half that in the 109 building (.48%). The hydrogen and oxygen concentrations in the source volume are increasing, and another burn could occur later. Table 5.6 shows the hydrogen concentrations at selected times for all volumes.

Before the initial burn, the mixture is nearly detonable. Lower concentrations (~13%) of dry hydrogen have been detonated [19]. The high steam concentration in this case may inhibit detonation, but there are significant uncertainties in detonation predictions. Also, the flame propagation speed model in HECTR is fairly simple and, if the burn proceeded significantly faster due to flame acceleration, the peak pressure could be substantially higher (the burn would need to proceed about five times faster before substantially higher pressures would occur).

5.7 Case 7

In Case 7, we moved the source to steam generator cell 4 which opens directly into the pipe gallery. All conditions are similar to Case 6S with the sump pumps operating as designed. The results were identical to Case 6S. If the pump did not work, the results would be similar to Case 6NS and Case 6B. This would be true of a break in any steam generator cell for this accident scenario.

5.8 Case 8

Case 8 has the same initial conditions as Case 3 (i.e., a 38-volume model with the extended NUSAR sources in volume 24), except that the sprays are turned off. The results are very similar to that case; however, the pressures and temperatures remain slightly higher. The steam concentrations remain higher since the sprays are not inducing condensation. The flow reversal with outflow from the filter building occurs about 2,000 s earlier in this case than that with the sprays as the source compensates for the residual condensation much earlier. Table 5.7 shows the hydrogen concentration at selected times for all volumes.

5.9 Case 9

Case 9 was identical to the base case except that the hydrogen source term was exponentially extrapolated out to 18,000 s. This was done to examine the long-term behavior of the hydrogen in the confinement. As shown in Figures 5.22 and 5.23 and Table 5.8, the hydrogen concentrations level out in the 109 building due to the outflow through the filter building and the decreasing source. Concentrations are still increasing in the 105 building, but should always remain below those in the 109 building.

5.10 Case 10

Case 10 is a reanalysis of case 6NS using a 65-volume model. The postulated accident was assumed to occur in the lower corner of steam generator cell 6 (volume 28). The source term was the same as case 6NS and the sump pumps do not operate.

5.10.1 The first 500 Seconds

The first 500 seconds were identical to the case 6NS results with the sump being filled and the lower junctions to the pipe gallery extension, therefore, blocked.

5.10.2 Long-term Behavior

The more detailed nodalization and the subdividing of the ducts into six junctions results in significantly more mixing between the steam generator cell and the pipe gallery than in case 6 NS. The hot steam and hydrogen rise towards the rear of the steam generator cell and flow out through the upper level into the pipe gallery. There, the sprays condense the steam and lower the temperature. The gases sink down and some flows back into the steam generator cell through the lower level of the duct junctions; the rest flows out into the main pipe gallery where it is cooled further. A flow pattern is set up in the pipe gallery where gas flows from the extension into the upper pipe gallery, then down and back into the lower part of the extension. This results in more flow into the steam generator cell through the lower duct junctions. The flow is also into the top of the other steam generator and auxiliary cells and out the lower junctions. Figure 5.24 shows the general flow pattern set up after 800 seconds.

Figures 5.25, 26 and 27 show the hydrogen concentration with time for the source cell (volume 28), an upper level cell in the pipe gallery extension (volume 25), and a middle level cell in the pipe gallery (volume 22). These show that hydrogen is drawn out of steam generator cell 6 at the top level, mixes into the main pipe gallery area and other steam generator and auxiliary cells, and then flows back into steam generator cell 6 through the lower duct junctions. The result is that, after some time lapse, the hydrogen is fairly uniformly mixed in the 109 building with slightly higher concentrations in the steam generator cell, then in the upper level of the pipe gallery extension, and least in the pipe gallery and other steam generator cells.

The results show that with adequate nodalization HECTR can predict similar results to COBRA-NC for cases where the flows are dominated by temperature (density) and condensation effects.

TABLE 5.1
HYDROGEN CONCENTRATIONS FOR CASE 2

VOLUME	TIME(S) 600	834	1508	3014	6077	13000
1	0	0	0	0	0	.0006
2	0	0	0	0	0	.0054
3	.0003	.0037	.0118	.0187	.0266	.0356
4	.0003	.0067	.0128	.0193	.0273	.0355
5	.0012	.0062	.0128	.0193	.0271	.0354
6	.0018	.0048	.0131	.0195	.0270	.0353
7	.0003	.0070	.0129	.0194	.0273	.0355
8	.0082	.0200	.0188	.0227	.0297	.0359
9	.0030	.0056	.0132	.0196	.0271	.0354
10	.0003	.0073	.0130	.0194	.0271	.0354
11	.0004	.0188	.0180	.0221	.0290	.0360
12	.0003	.0066	.0133	.0196	.0270	.0353
13	0	.0001	.0005	.0009	.0012	.0020
14	.0004	.0026	.0112	.0184	.0260	.0333
15	0	0	0	0	0	0

TABLE 5.2
HYDROGEN CONCENTRATIONS FOR CASE 3

	TIME(S)					
VOLUME	602	802	1506	3018	6036	13001
1	0	0	0	0	0	.0025
2	0	0	0	0	0	.0024
3	0	0	0	0	0	.0026
4	0	0	0	0	0	.0025
5	0	0	0	0	0	.0026
6	0	0	0	0	0	.0030
7	0	0	0	0	0	.0040
8	0	0	0	0	0	.0029
9	0	0	0	0	0	.0031
10	0	0	0	0	0	.0024
11	0	0	0	0	0	.0024
12	0	0	0	0	0	.0025
13	0	0	0	0	0	.0039
14	0	0	0	0	0	.0032
15	0	0	0	0	0	.0032
16	0	0	0	0	0	.0021
17	0	0	0	0	0	.0035
18	0	0	0	0	0	0
19	.0003	.0024	.0116	.0183	.0259	.0359
20	.0007	.0052	.0142	.0193	.0270	.0361
21	.0006	.0047	.0140	.0192	.0271	.0361
22	.0005	.0031	.0134	.0186	.0273	.0362
23	.0009	.0059	.0143	.0194	.0271	.0362
24	.0079	.0234	.0265	.0287	.0297	.0365
25	.0023	.0081	.0155	.0204	.0276	.0363
26	.0011	.0065	.0144	.0194	.0264	.0362
27	.0026	.0129	.0177	.0215	.0295	.0364
28	.0010	.0038	.0124	.0189	.0274	.0363
29	0	.0001	.0005	.0009	.0012	.0014
30	.0001	.0010	.0098	.0174	.0250	.0327
31	.0004	.0028	.0131	.0186	.0255	.0325
32	.0004	.0028	.0131	.0186	.0255	.0325
33	.0002	.0012	.0062	.0197	.0263	.0344
34	.0005	.0021	.0107	.0180	.0262	.0334
35	.0005	.0020	.0107	.0180	.0262	.0334
36	.0005	.0020	.0107	.0180	.0262	.0334
37	0	0	0	0	0	.0005
38	0	0	0	0	0	.0025

TABLE 5.3
HYDROGEN CONCENTRATIONS FOR CASE 4
TIME (SEC)

VOLUME	600	800	1500	3000	6000	10000
1	.0017	.0109	.0283	.0280	.0277	.0263
2	.0007	.0054	.0199	.0217	.0248	.0255
3	.0003	.0031	.0166	.020	.0242	.0252
4	.0008	.0006	.0124	.0154	.0203	.0222
5	.0005	.0023	.0164	.0191	.0233	.0246
6	.0002	.0017	.0143	.0186	.0229	.0246
7	.0004	.0008	.0110	.0156	.0201	.0217
8	.0003	.0011	.0131	.0166	.0215	.0228
9	.0002	.0011	.0062	.0114	.0191	.0208
10	.0002	.0111	.0146	.0189	.0276	.0262
11	.0002	.0021	.0161	.0199	.0246	.0254
12	.0003	.0024	.0163	.0199	.0241	.0251
13	.0002	.0008	.0117	.0161	.0202	.0218
14	.0002	.0008	.0123	.0163	.0203	.0217
15	.0002	.0007	.0047	.0179	.0189	.0208
16	.0105	.0525	.0497	.0359	.0386	.0378
17	.0002	.0004	.0047	.0113	.0185	.0209
18	0	0	0	0	0	0
19	0	.0024	.0116	.0183	.0259	.0359
20	0	.0052	.0142	.0193	.0270	.0361
21	0	.0047	.0140	.0192	.0271	.0361
22	0	.0031	.0134	.0186	.0273	.0362
23	0	.0059	.0143	.0194	.0271	.0362
24	0	.0234	.0265	.0287	.0297	.0365
25	0	.0081	.0155	.0204	.0276	.0363
26	.0001	.0065	.0144	.0194	.0264	.0362
27	0	.0129	.0177	.0215	.0295	.0364
28	0	.0038	.0124	.0189	.0274	.0363
29	0	.0001	.0005	.0009	.0012	.0014
30	0	.0010	.0098	.0174	.0250	.0327
31	0	.0028	.0131	.0186	.0255	.0325
32	0	.0028	.0131	.0186	.0255	.0325
33	0	.0012	.0062	.0197	.0263	.0064
34	0	.0021	.0107	.0180	.0262	.0063
35	0	.0020	.0107	.0180	.0262	.0063
36	0	.0020	.0107	.0180	.0262	.0063
37	0	0	0	0	0	.0014
38	0	0	.0040	.0146	.0235	.0247

TABLE 5.4
HYDROGEN CONCENTRATIONS FOR CASE 5

VOLUME	TIME(S) 600	800	1504	3002	6005	10000
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	.0001
8	0	0	0	0	0	0
9	0	0	0	0	0	.0001
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	.0001
14	0	0	0	0	0	.0001
15	0	0	0	0	0	.0001
16	0	0	0	0	0	0
17	0	0	0	0	0	.0001
18	0	0	0	0	0	0
19	0	0	.0004	.0008	.0025	.0041
20	0	0	.0005	.0008	.0027	.0043
21	0	0	.0005	.0010	.0031	.0045
22	0	0	.0005	.0010	.0029	.0047
23	0	.0001	.0005	.0009	.0027	.0043
24	0	0	.0005	.0011	.0031	.0045
25	0	0	.0005	.0010	.0028	.0047
26	0	.0001	.0005	.0009	.0021	.0038
27	0	.0004	.0007	.0012	.0032	.0052
28	0	0	.0003	.0008	.0020	.0048
29	.0194	.0954	.3281	.4978	.6349	.7073
30	0	0	.0003	.0007	.0022	.0038
31	0	0	.0004	.0008	.0019	.0036
32	0	0	.0004	.0008	.0019	.0036
33	0	0	.0001	.0006	.0022	.0038
34	0	0	.0003	.0008	.0019	.0044
35	0	0	.0003	.0008	.0019	.0044
36	0	0	.0003	.0008	.0019	.0044
37	0	0	0	0	0	0
38	0	0	0	0	0	0

TABLE 5.5
HYDROGEN CONCENTRATIONS FOR CASE 6S

	TIME(S)					
VOLUME	602	802	1502	3000	6011	10000
1	0	0	0	0	0	.0001
2	0	0	0	0	0	.0001
3	0	0	0	0	0	.0001
4	0	0	0	0	0	.0001
5	0	0	0	0	0	.0001
6	0	0	0	0	0	.0001
7	0	0	0	0	0	.0002
8	0	0	0	0	0	.0001
9	0	0	0	0	0	.0001
10	0	0	0	0	0	.0001
11	0	0	0	0	0	.0001
12	0	0	0	0	0	.0001
13	0	0	0	0	0	.0001
14	0	0	0	0	0	.0001
15	0	0	0	0	0	.0001
16	0	0	0	0	0	.0001
17	0	0	0	0	0	0
18	0	0	0	0	0	0
19	.0002	.0017	.0103	.0125	.0154	.0172
20	0	.0003	.0053	.0091	.0136	.0163
21	0	.0003	.0039	.0087	.0135	.0162
22	0	.0002	.0036	.0084	.0132	.0156
23	0	.0004	.0054	.0102	.0139	.0165
24	0	.0003	.0028	.0088	.0135	.0162
25	0	.0001	.0032	.0083	.0119	.0156
26	0	.0001	.0055	.0112	.0149	.0170
27	0	.0004	.0020	.0088	.0146	.0168
28	0	.0001	.0021	.0068	.0109	.0156
29	0	0	0	0	.0001	.0001
30	.0034	.0159	.0330	.0207	.0181	.0182
31	0	.0002	.0044	.0109	.0146	.0168
32	0	.0002	.0044	.0109	.0146	.0168
33	0	0	.0003	.0043	.0114	.0147
34	0	0	.0016	.0063	.0105	.0154
35	0	0	.0016	.0063	.0105	.0154
36	0	0	.0016	.0063	.0105	.0154
37	0	0	0	0	0	0
38	0	0	0	0	0	.0001

TABLE 5.6
HYDROGEN CONCENTRATIONS FOR CASE 6B

	TIME(S)						
VOLUME	601	802	1507	3014	6038	8959	10000
1	0	0	0	0	0	0	.0018
2	0	0	0	0	0	0	.0018
3	0	0	0	0	0	0	.0018
4	0	0	0	0	0	0	.0019
5	0	0	0	0	0	0	.0018
6	0	0	0	0	0	0	.0018
7	0	0	0	0	0	0	.0019
8	0	0	0	0	0	0	.0018
9	0	0	0	0	0	0	.0018
10	0	0	0	0	0	0	.0018
11	0	0	0	0	0	0	.0018
12	0	0	0	0	0	0	.0018
13	0	0	0	0	0	0	.0018
14	0	0	0	0	0	0	.0018
15	0	0	0	0	0	0	.0018
16	0	0	0	0	0	0	.0017
17	0	0	0	0	0	0	.0013
18	0	0	0	0	0	0	0
19	0	0	0	0	0	.0004	.0049
20	0	0	0	0	0	.0001	.0049
21	0	0	0	0	0	.0001	.0047
22	0	0	0	0	0	.0001	.0047
23	0	0	0	0	0	.0002	.0049
24	0	0	0	0	0	.0001	.0047
25	0	0	0	0	0	.0001	.0047
26	0	0	0	0	0	.0003	.0052
27	0	0	0	0	0	.0001	.0048
28	0	0	0	0	0	0	.0047
29	0	0	0	0	0	0	.0011
30	.0036	.0179	.0642	.1025	.1442	.1718	.0208
31	0	0	0	0	0	.0002	.0053
32	0	0	0	0	0	.0002	.0053
33	0	0	0	0	0	.0001	.0040
34	0	0	0	0	0	0	.0045
35	0	0	0	0	0	0	.0045
36	0	0	0	0	0	0	.0045
37	0	0	0	0	0	0	.0002
38	0	0	0	0	0	0	.0018

Table 5.7
HYDROGEN CONCENTRATIONS FOR CASE 8

	TIME(S)					
VOLUME	601	801	1509	3019	6059	8967
1	0	0	0	0	0	.0004
2	0	0	0	0	0	.0004
3	0	0	0	0	0	.0005
4	0	0	0	0	0	.0004
5	0	0	0	0	0	.0004
6	0	0	0	0	0	.0005
7	0	0	0	0	0	.0016
8	0	0	0	0	0	.0011
9	0	0	0	0	0	.0010
10	0	0	0	0	0	.0004
11	0	0	0	0	0	.0004
12	0	0	0	0	0	.0005
13	0	0	0	0	0	.0001
14	0	0	0	0	0	.0003
15	0	0	0	0	0	0
16	0	0	0	0	0	.0004
17	0	0	0	0	0	0
18	0	0	0	0	0	0
19	.0001	.0011	.0057	.0089	.0134	.0161
20	.0003	.0026	.0086	.0095	.0133	.0159
21	.0009	.0022	.0084	.0111	.0159	.0182
22	.0007	.0013	.0079	.0109	.0157	.0180
23	.0004	.0031	.0087	.0105	.0142	.0162
24	.0041	.0134	.0155	.0160	.0187	.0187
25	.0012	.0048	.0094	.0113	.0157	.0180
26	.0004	.0035	.0087	.0106	.0143	.0167
27	.0012	.0072	.0106	.0115	.0149	.0173
28	.0005	.0020	.0068	.0103	.0146	.0173
29	0	0	.0003	.0006	.0008	.0009
30	0	.0003	.0038	.0076	.0128	.0157
31	.0001	.0011	.0049	.0099	.0138	.0163
32	.0001	.0011	.0049	.0099	.0138	.0163
33	.0001	.0010	.0060	.0102	.0136	.0160
34	.0002	.0010	.0055	.0095	.0135	.0168
35	.0002	.0010	.0055	.0095	.0135	.0168
36	.0002	.0010	.0055	.0095	.0135	.0168
37	0	0	0	0	0	0
38	0	0	0	0	0	.0004

Table 5.8

HYDROGEN CONCENTRATIONS FOR CASE 9

VOLUME	TIME(S) 1504	3018	6026	13001	15803	18000
1	0	0	0	.0003	.0009	.0016
2	0	0	0	.0024	.0045	.0059
3	.0058	.0094	.0133	.0179	.0194	.0198
4	.0063	.0097	.0135	.0178	.0195	.0197
5	.0063	.0097	.0135	.0178	.0194	.0197
6	.0066	.0098	.0135	.0177	.0194	.0196
7	.0064	.0097	.0136	.0178	.0195	.0198
8	.0100	.0115	.0149	.0180	.0198	.2000
9	.0066	.0098	.0135	.0178	.0194	.0196
10	.0064	.0096	.0134	.0178	.0193	.0195
11	.0090	.0110	.0143	.0181	.0198	.0200
12	.0065	.0097	.0134	.0177	.0192	.0194
13	.0003	.0005	.0006	.0010	.0012	.0014
14	.0056	.0092	.0129	.0167	.0175	.0177
15	0	0	0	0	.0000	.0001

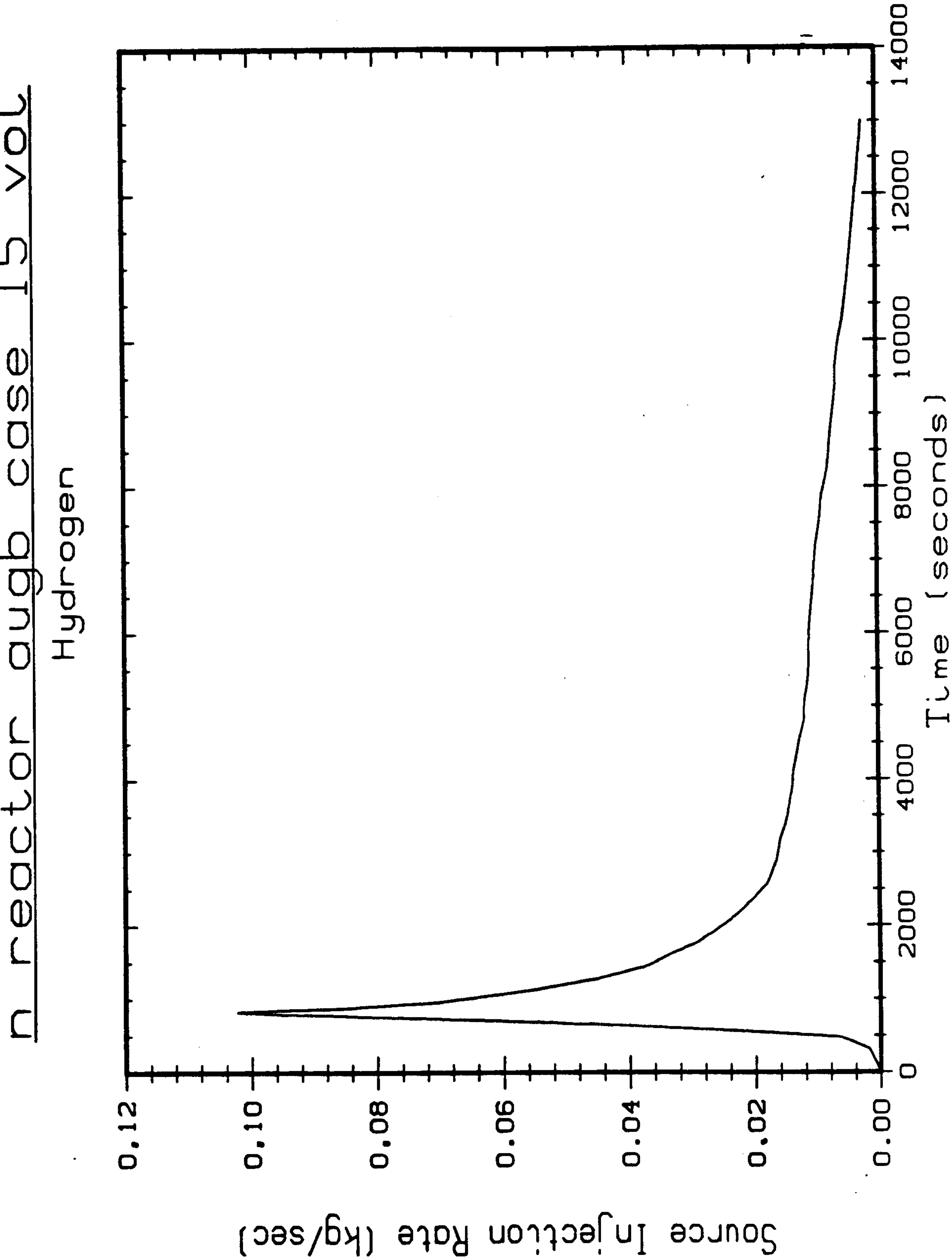


Figure 5.1. Double NUSAR Extended Hydrogen Rate

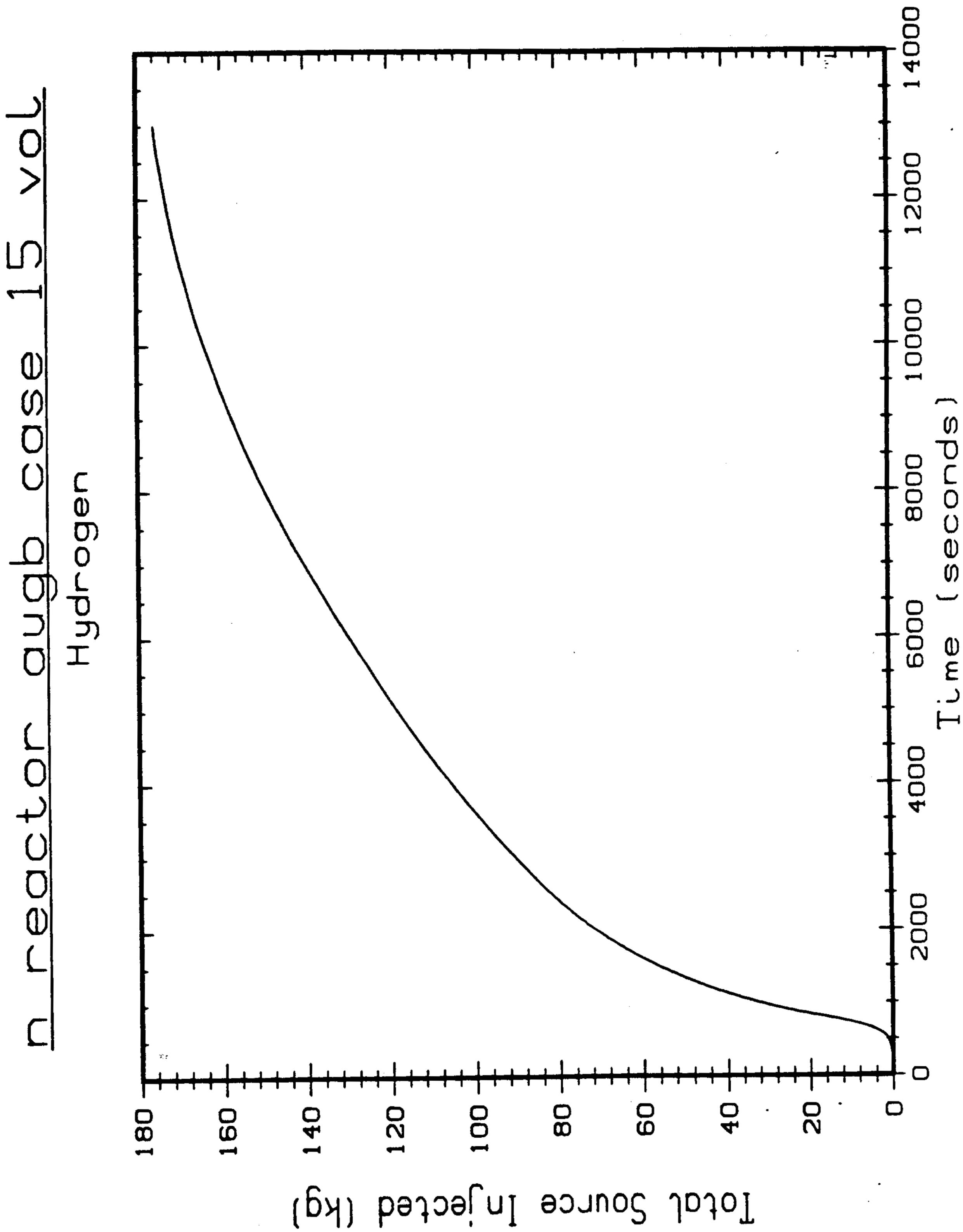


Figure 5.2. Double Total Hydrogen Injected

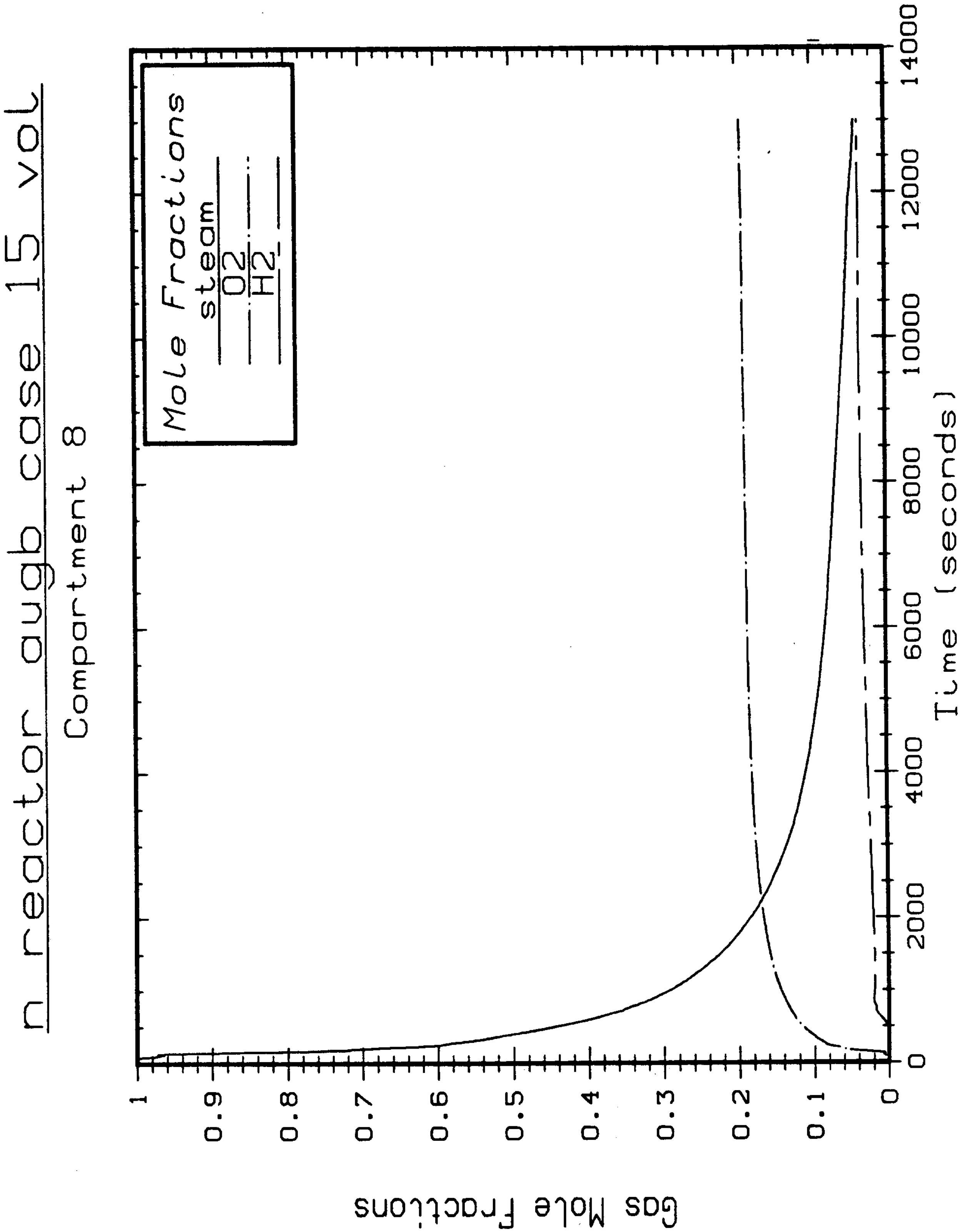


Figure 5.3. Case 2 Molar Concentrations for Volume 8

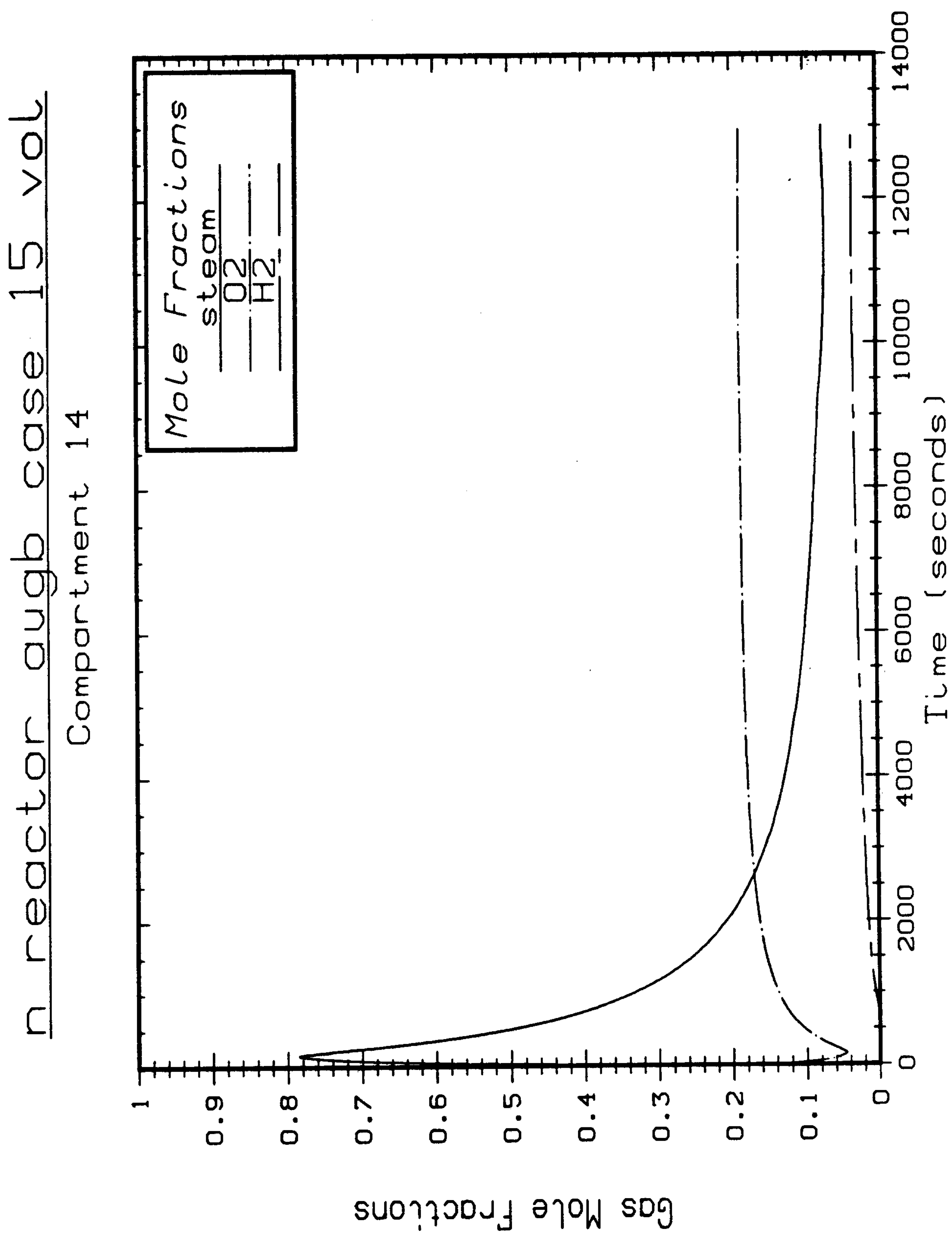


Figure 5.4. Case 2 Molar Concentrations for Volume 14

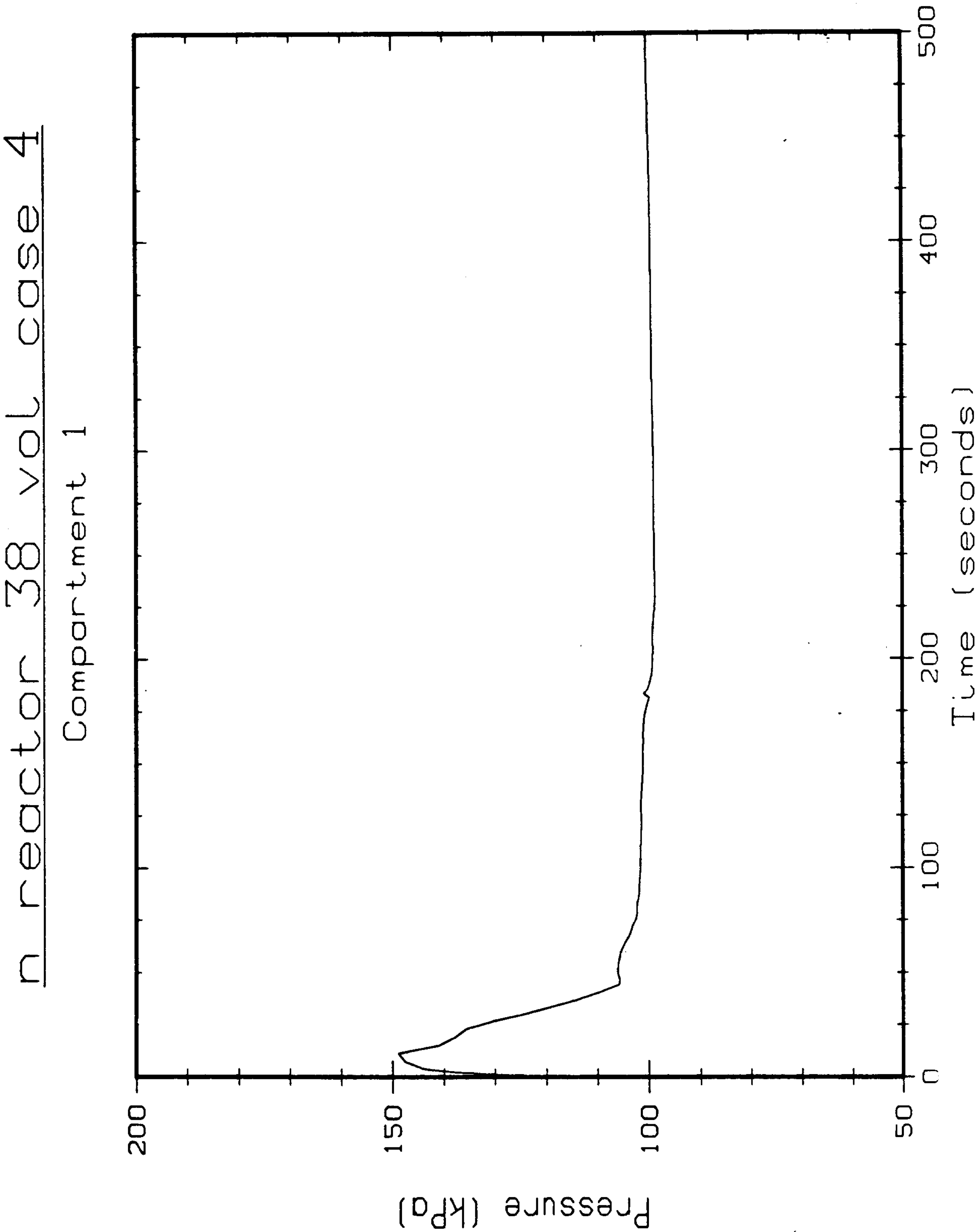


Figure 5.5. Case 4 Pressure in Volume 1 (500 s)

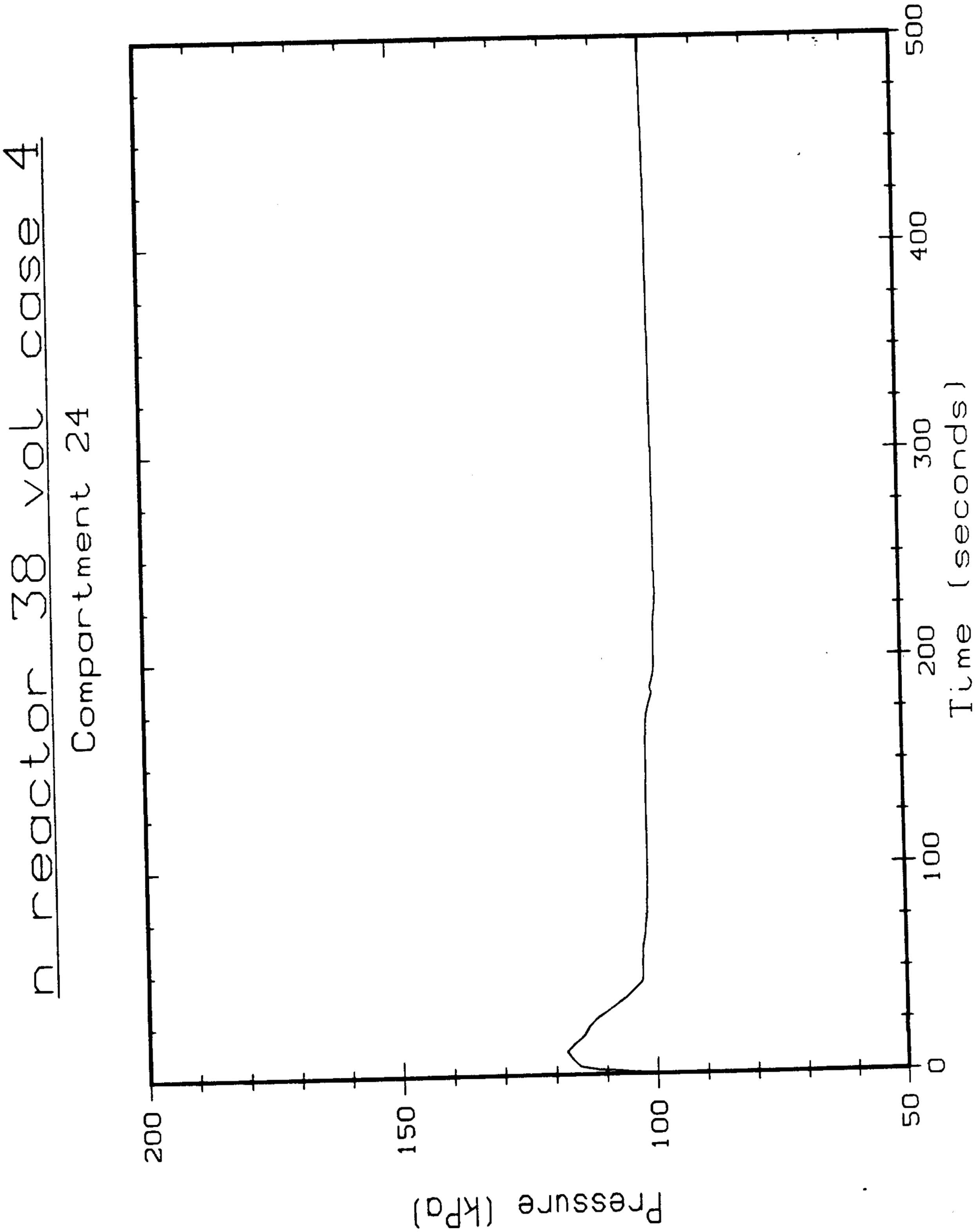


Figure 5.6. Case 4 Pressure in Volume 24 (500 s)

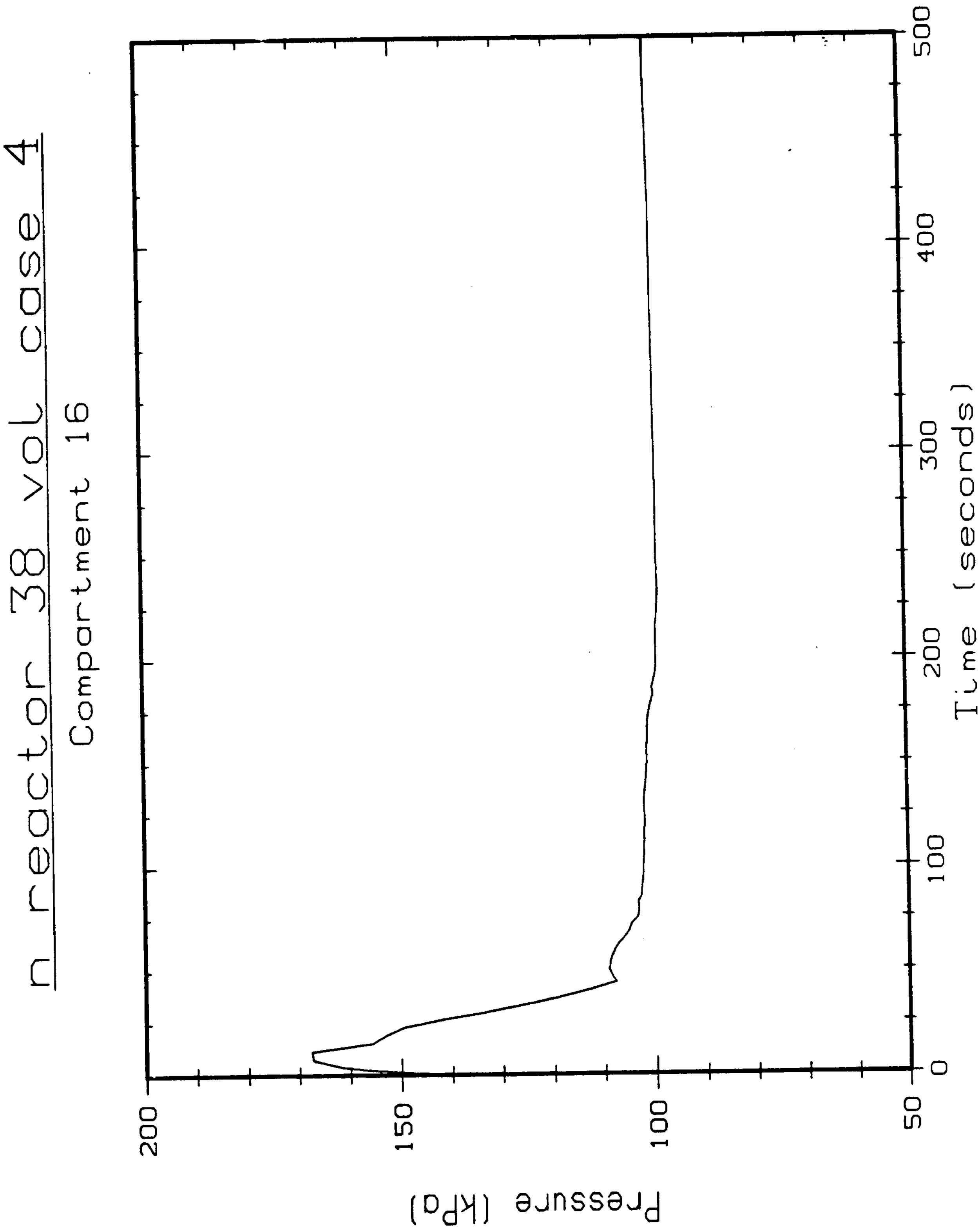


Figure 5.7. Case 4 Pressure in Volume 16 (500 s)

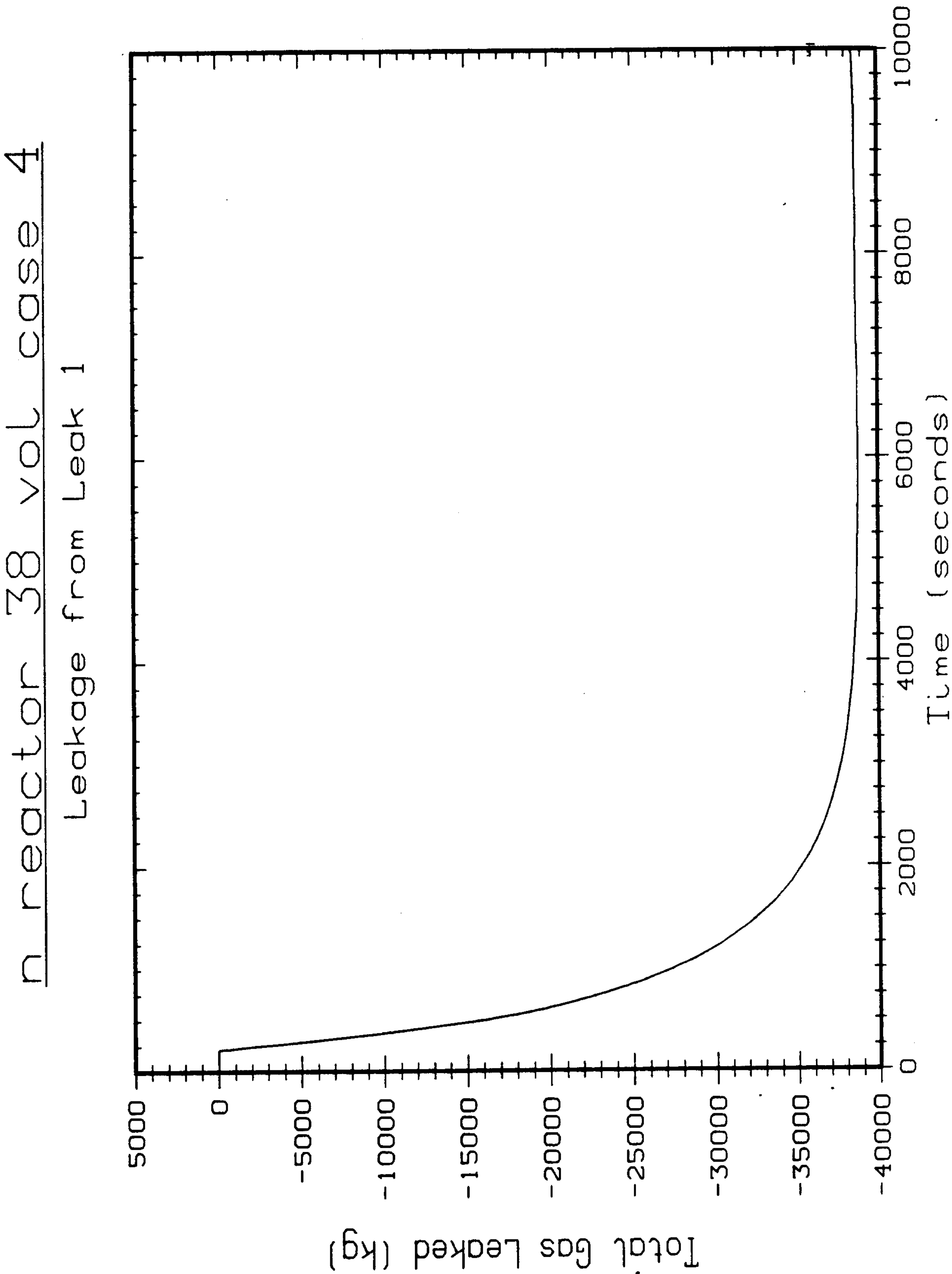


Figure 5.8. Case 4 Total Leakage from Filter Building

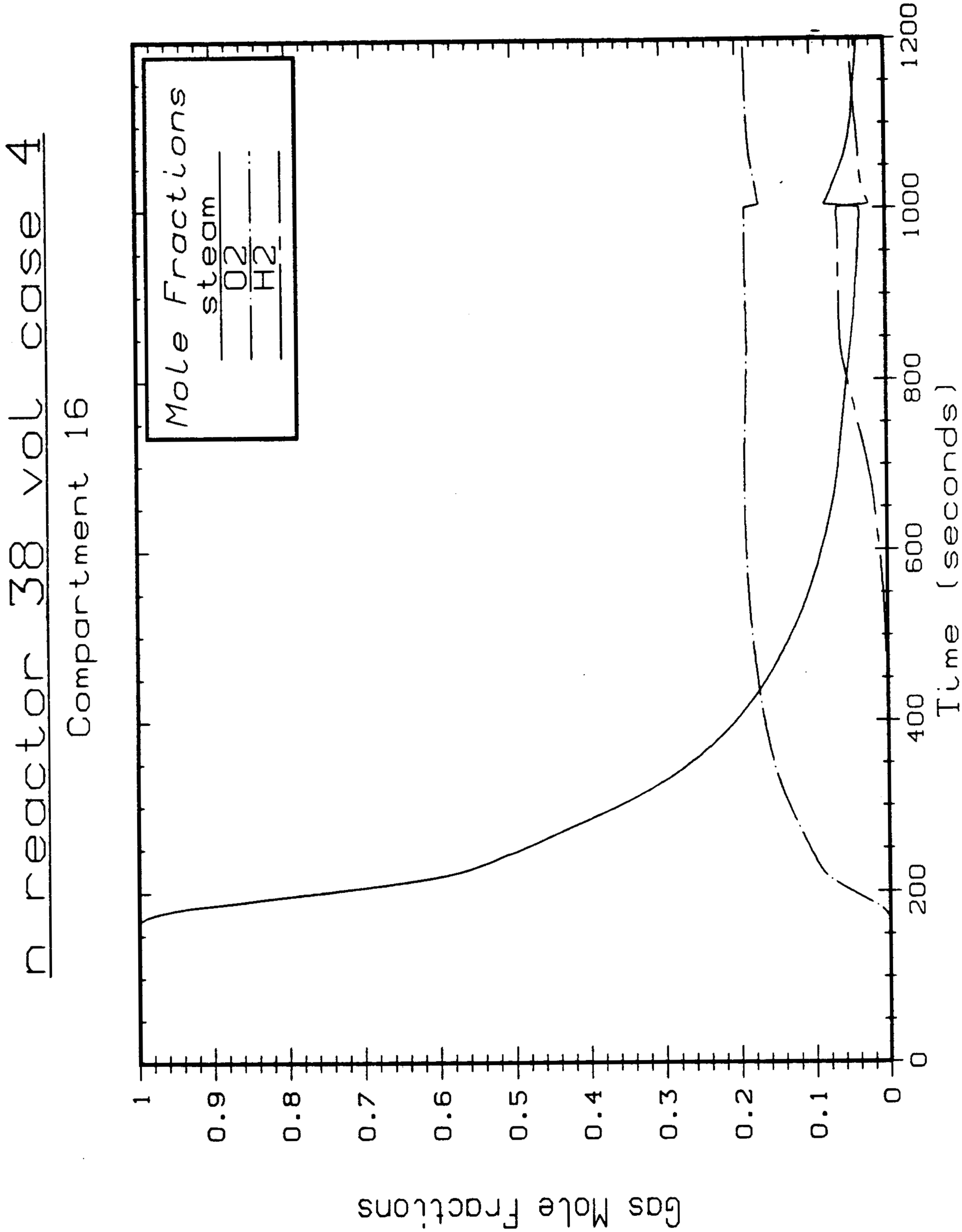


Figure 5.9. Case 4b Molar Concentrations for Volume 16 (500 s)

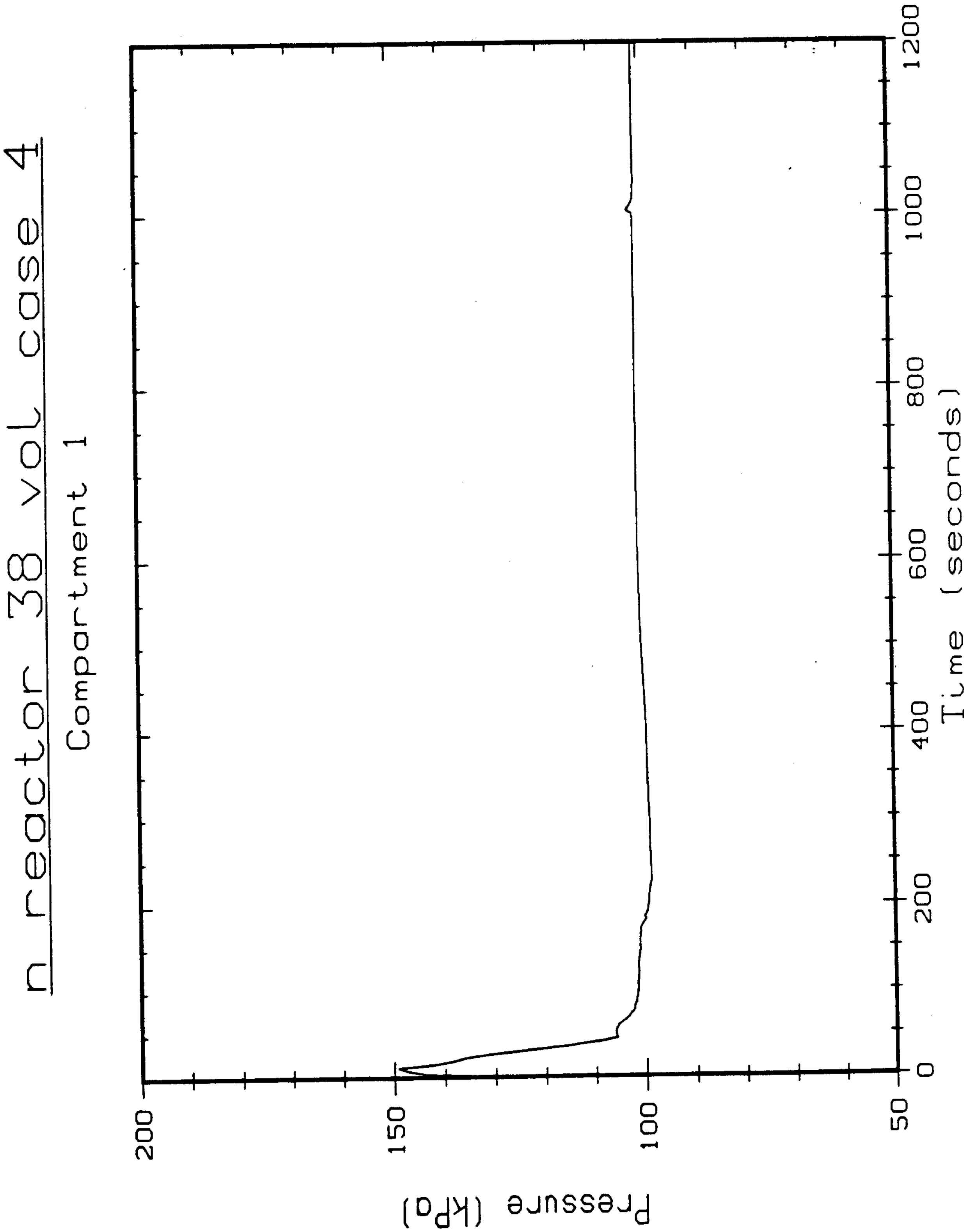


Figure 5.10. Case 4b Pressure in Volume 1 (1200 s)

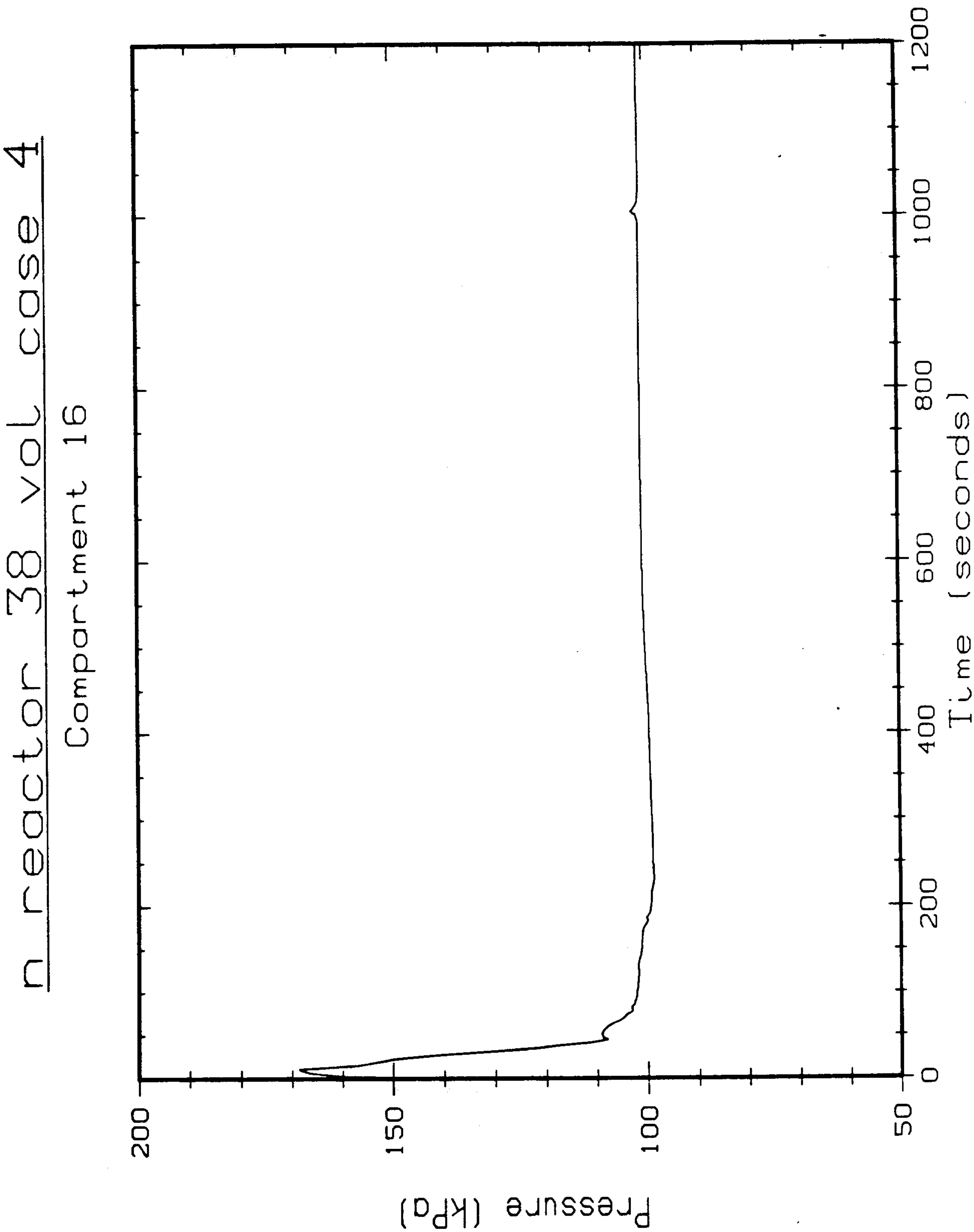


Figure 5.11. Case 4b Pressure in Volume 16 (1200 s)

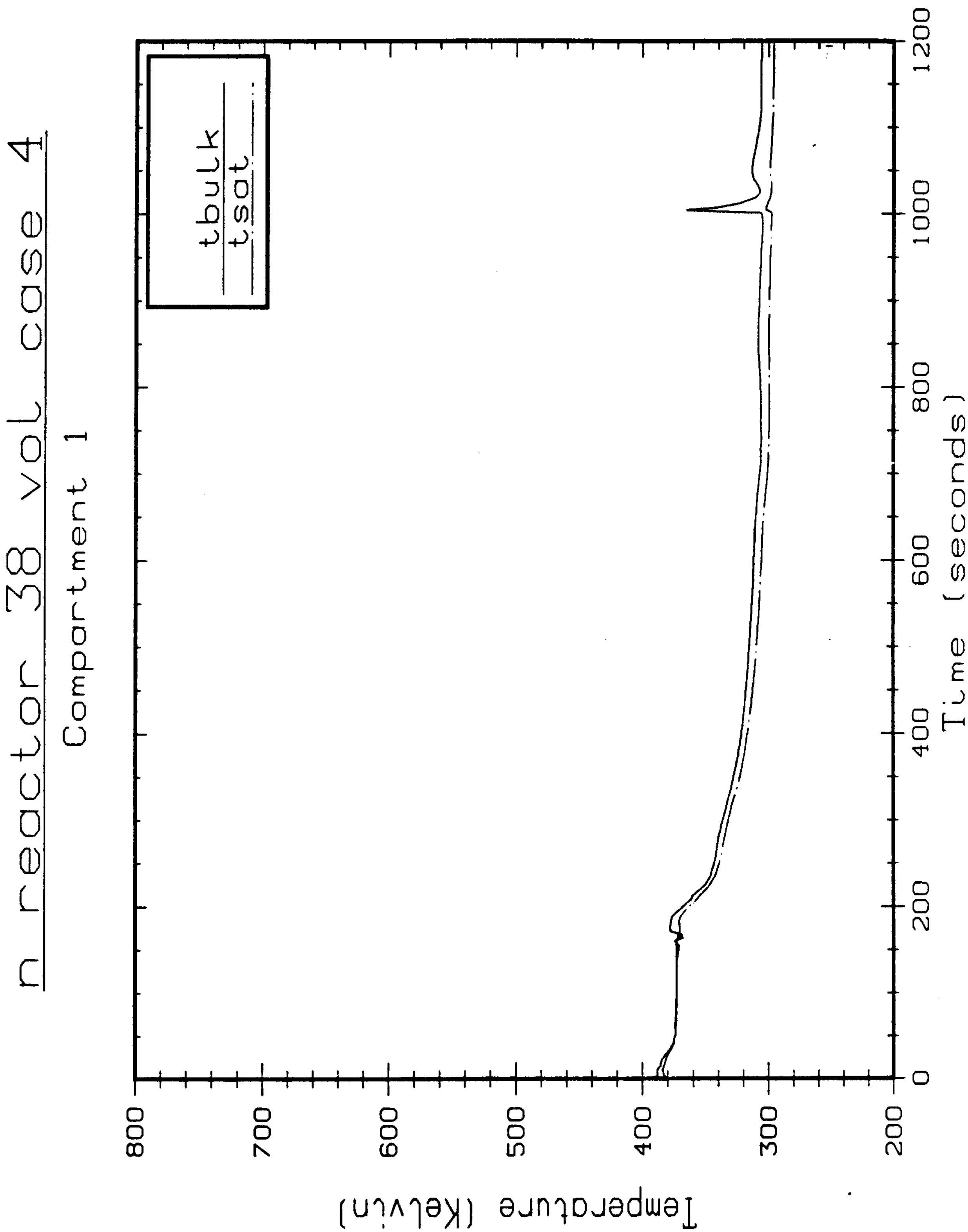


Figure 5.12. Case 4b Temperature in Volume 1 (1200 s)

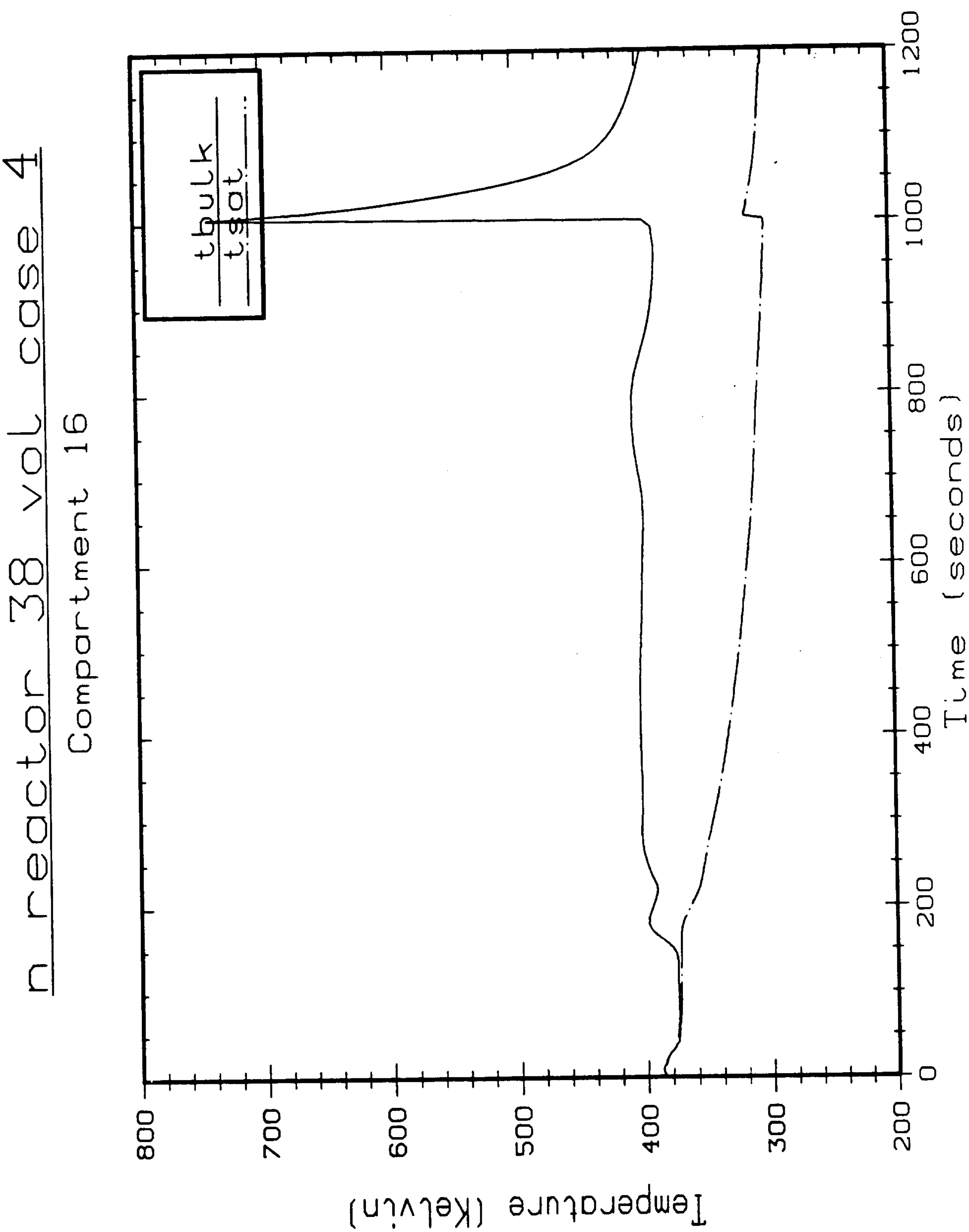


Figure 5.13. Case 4b Temperature in Volume 16 (1200 s)

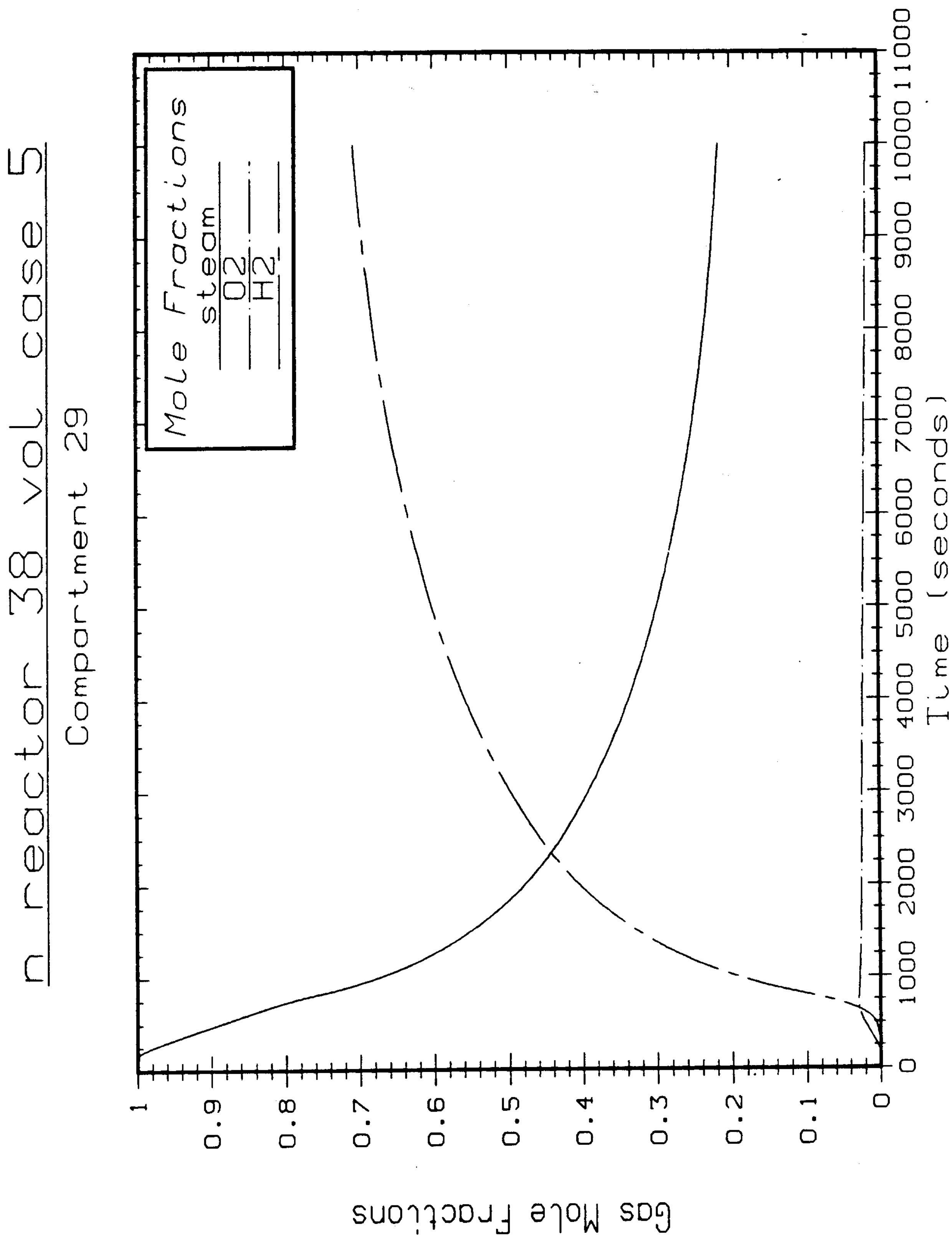


Figure 5.14. Case 5 Molar Concentrations in Volume 29 (10,000 s)

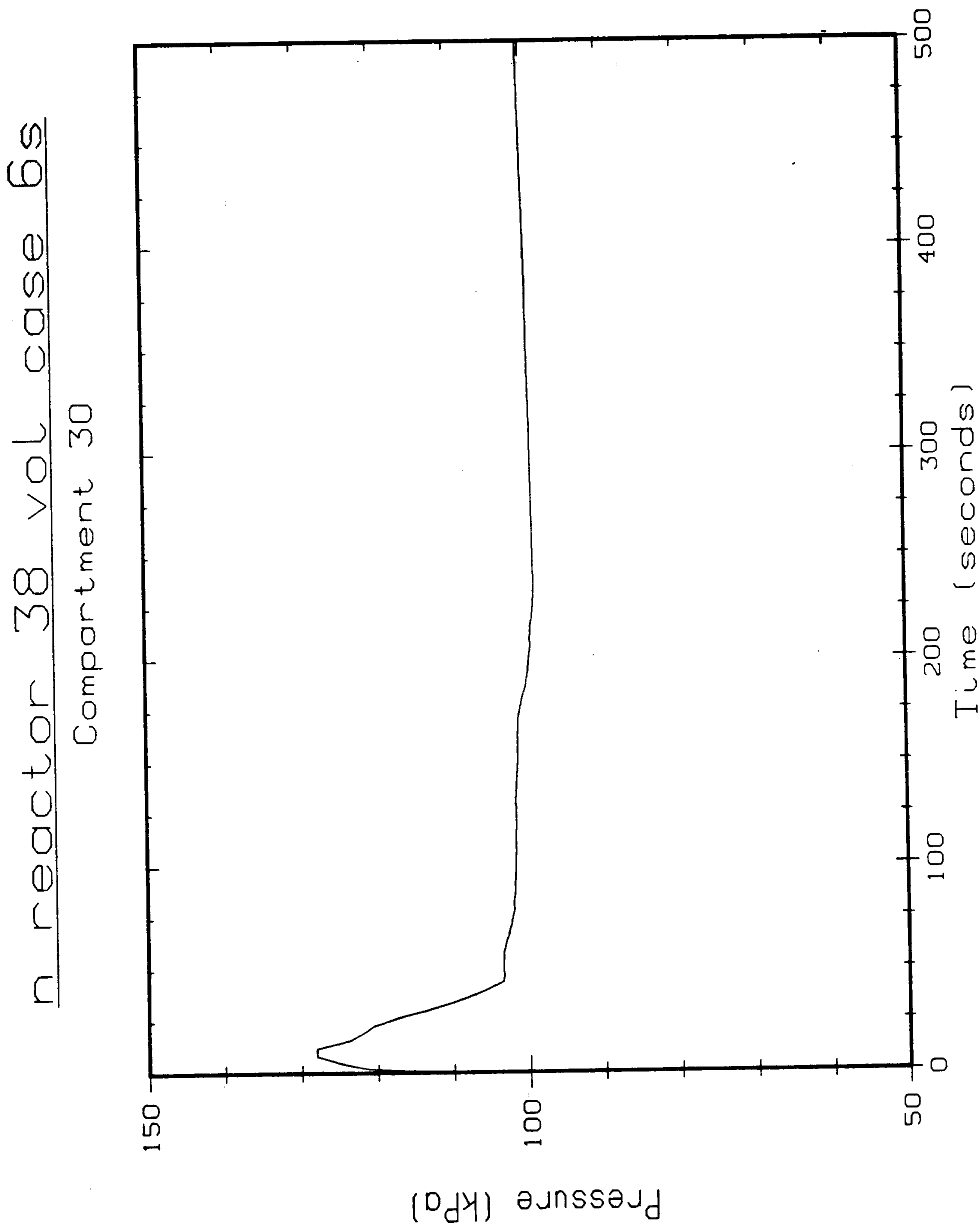


Figure 5.15. Case 6S Pressure in Volume 30 (500 s)

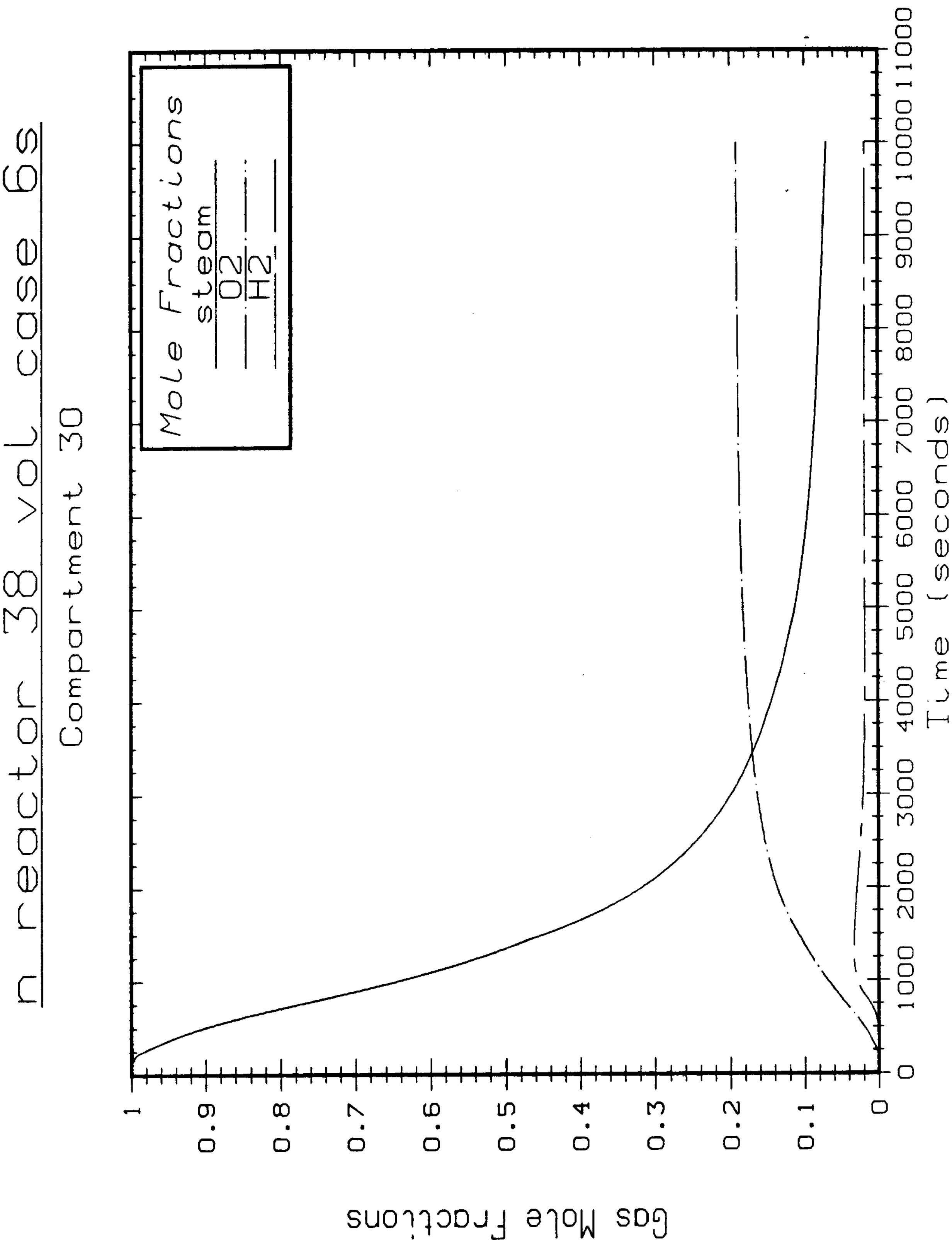


Figure 5.16. Case 6S Molar Concentrations in Volume 30 (10,000 s)

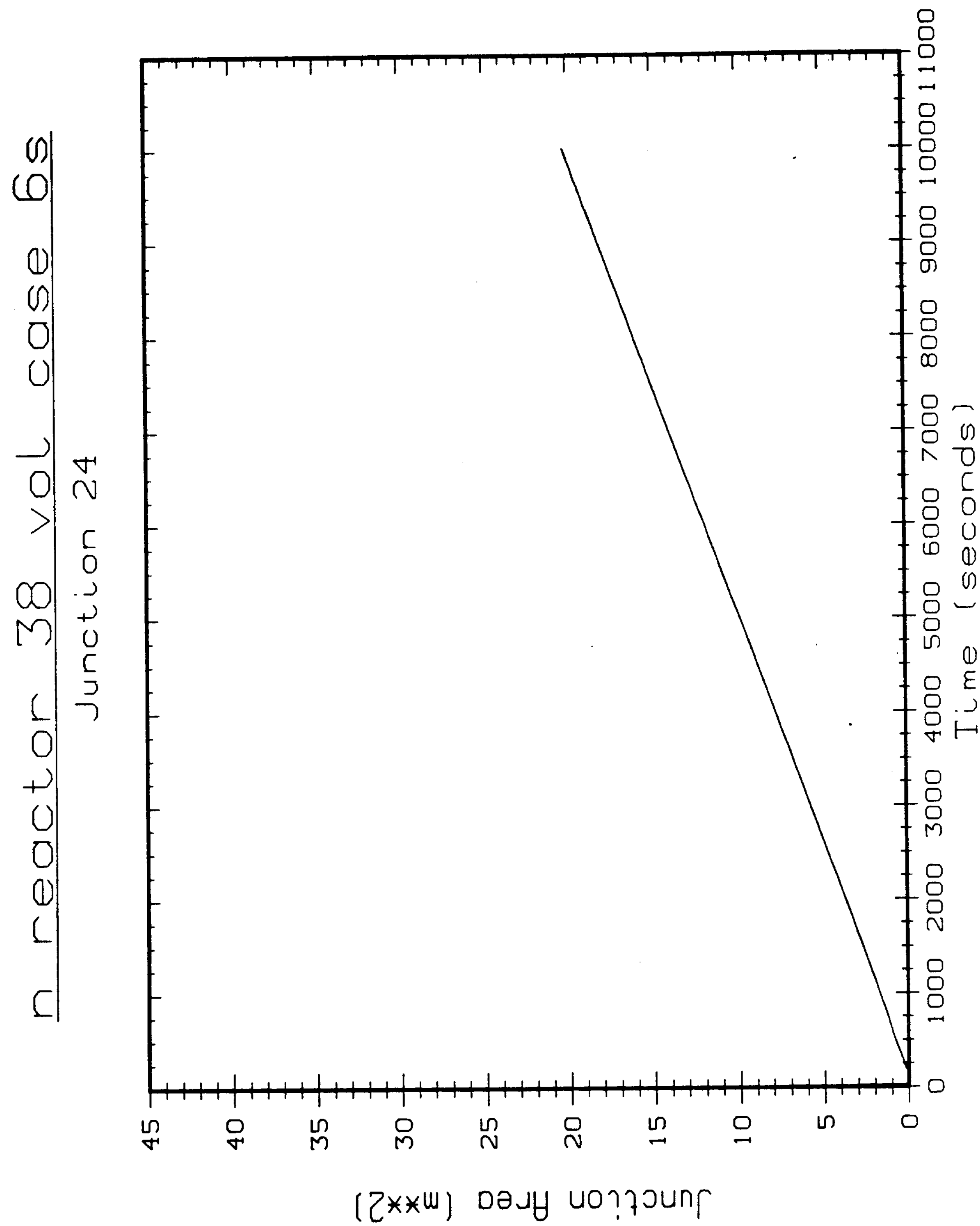


Figure 5.17. Case 6S Sump Area for Volume 30 Sump (10,000 s)

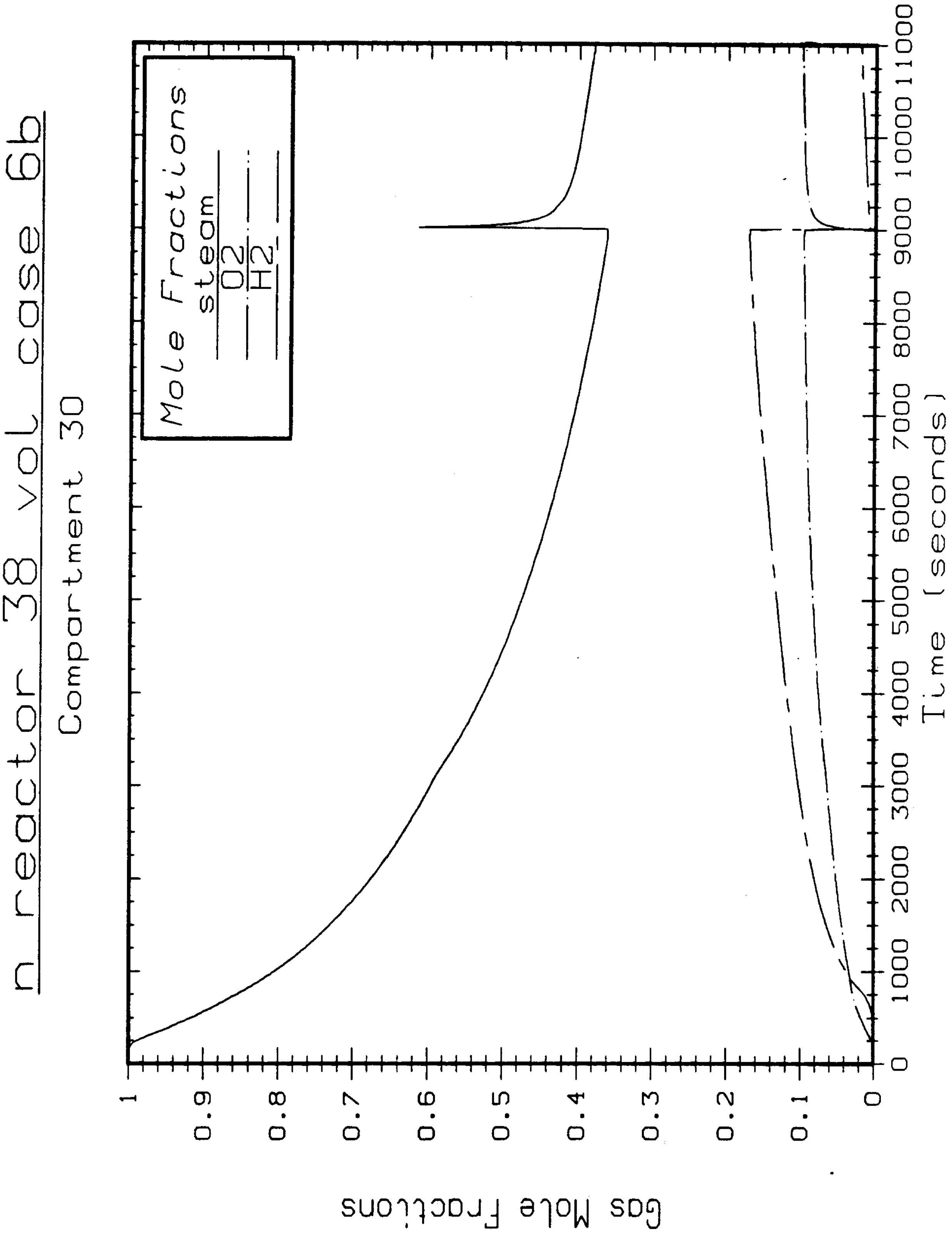


Figure 5.18. Case 6B Molar Concentrations in Volume 30 (11,000 s)

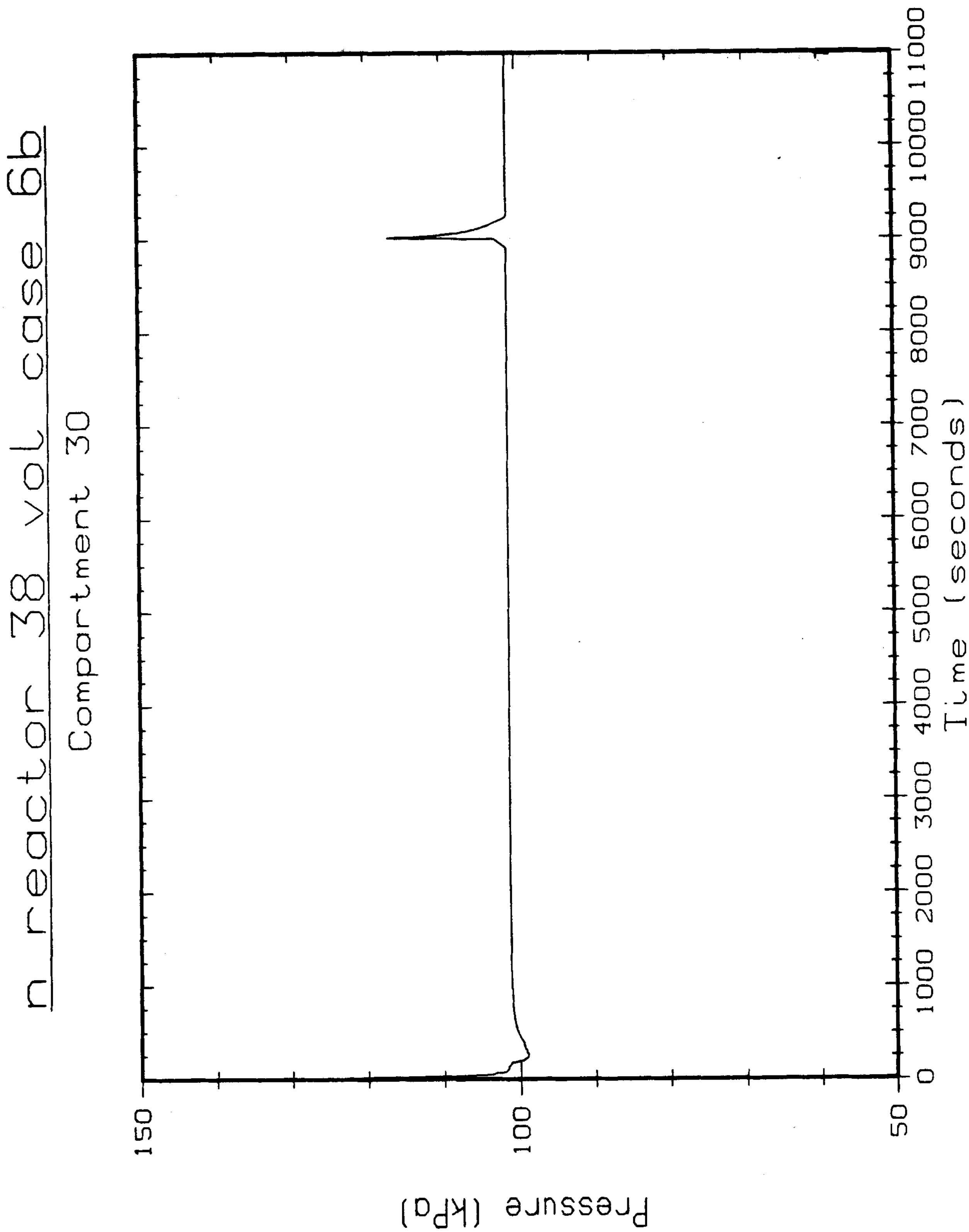


Figure 5.19. Case 6B Pressure in Volume 30 (11,000 s)

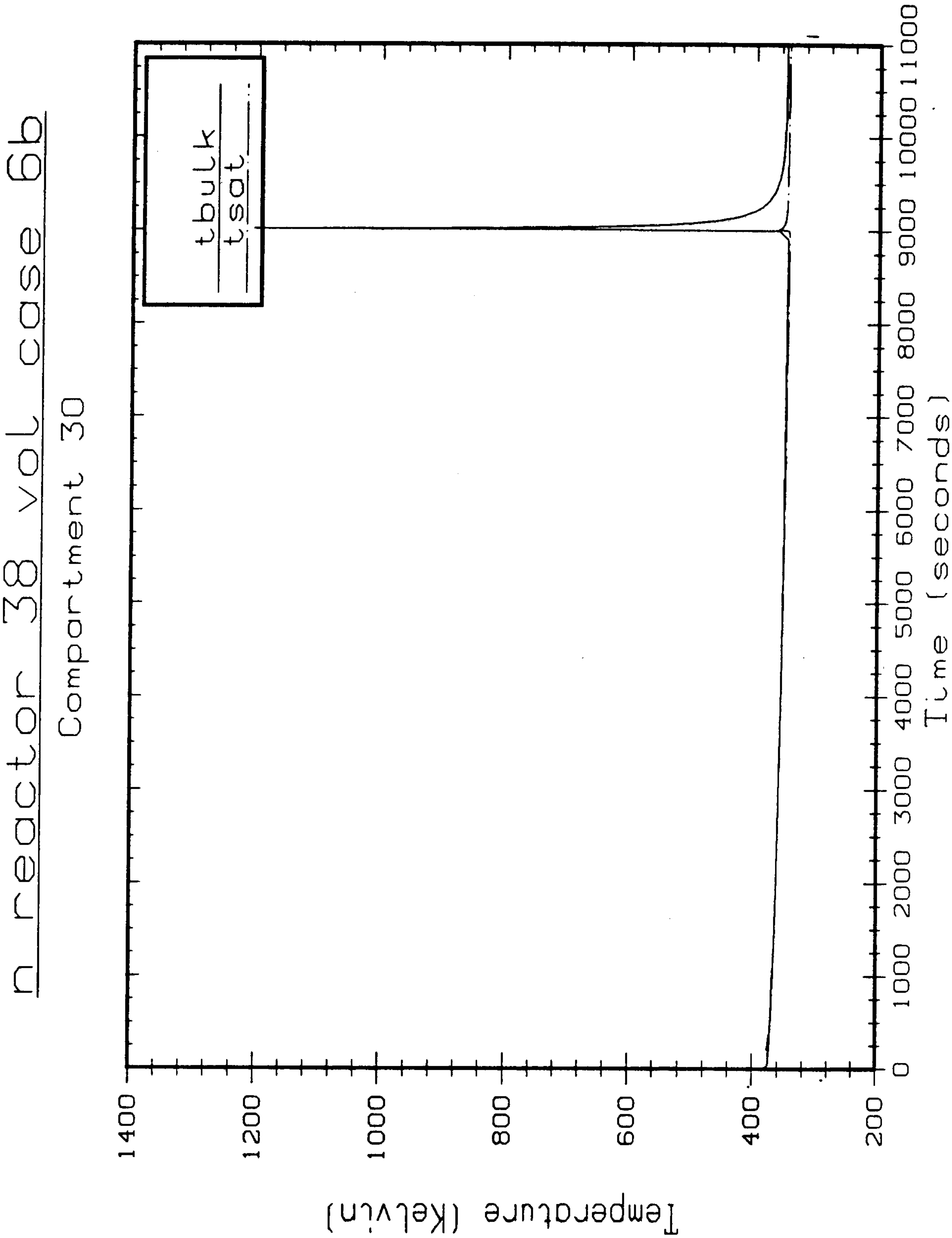


Figure 5.20. Case 6B Temperature in Volume 30 (11,000 s)

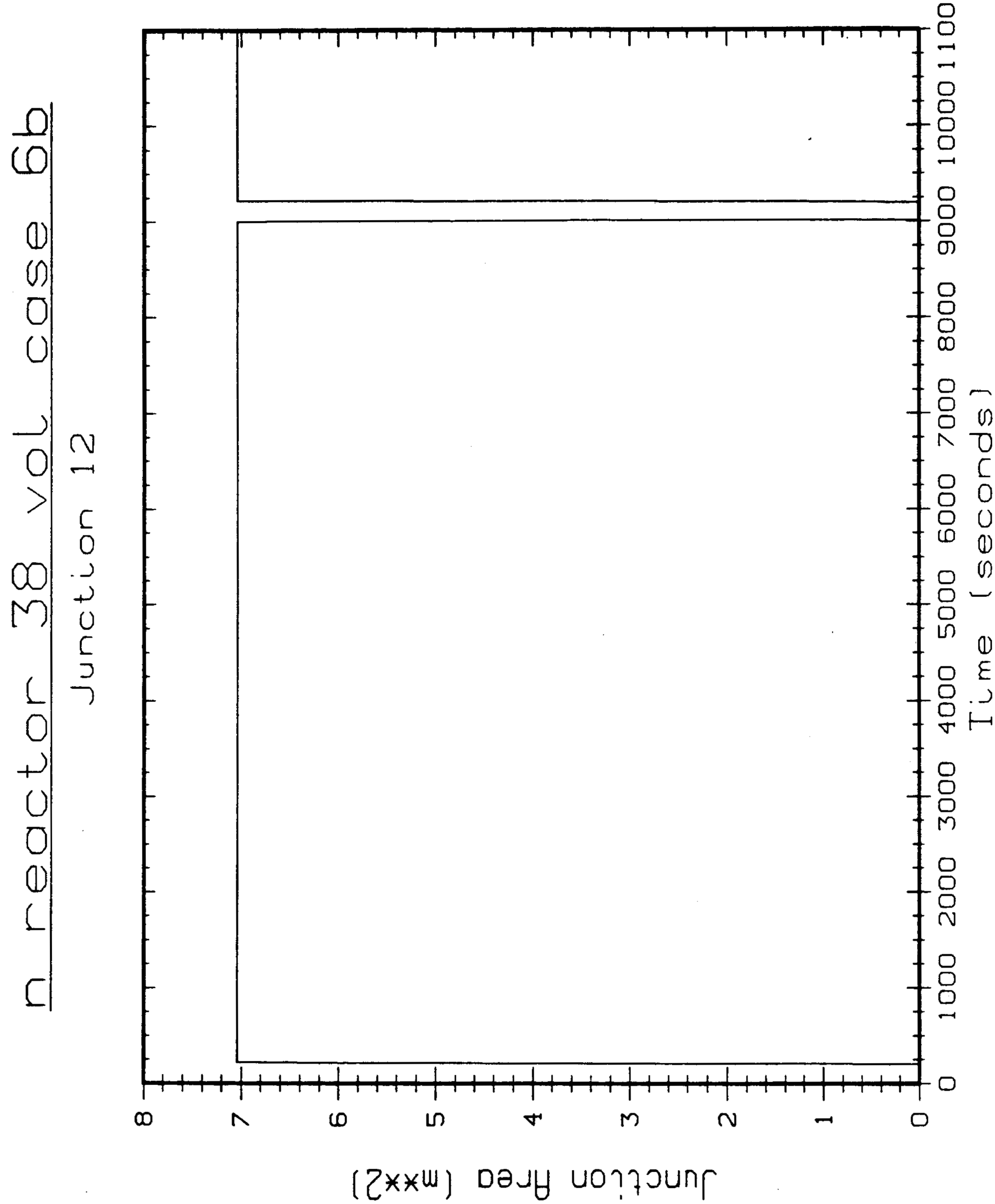


Figure 5.21. Case 6B Confinement Exhaust Valve Area (11,000 s)

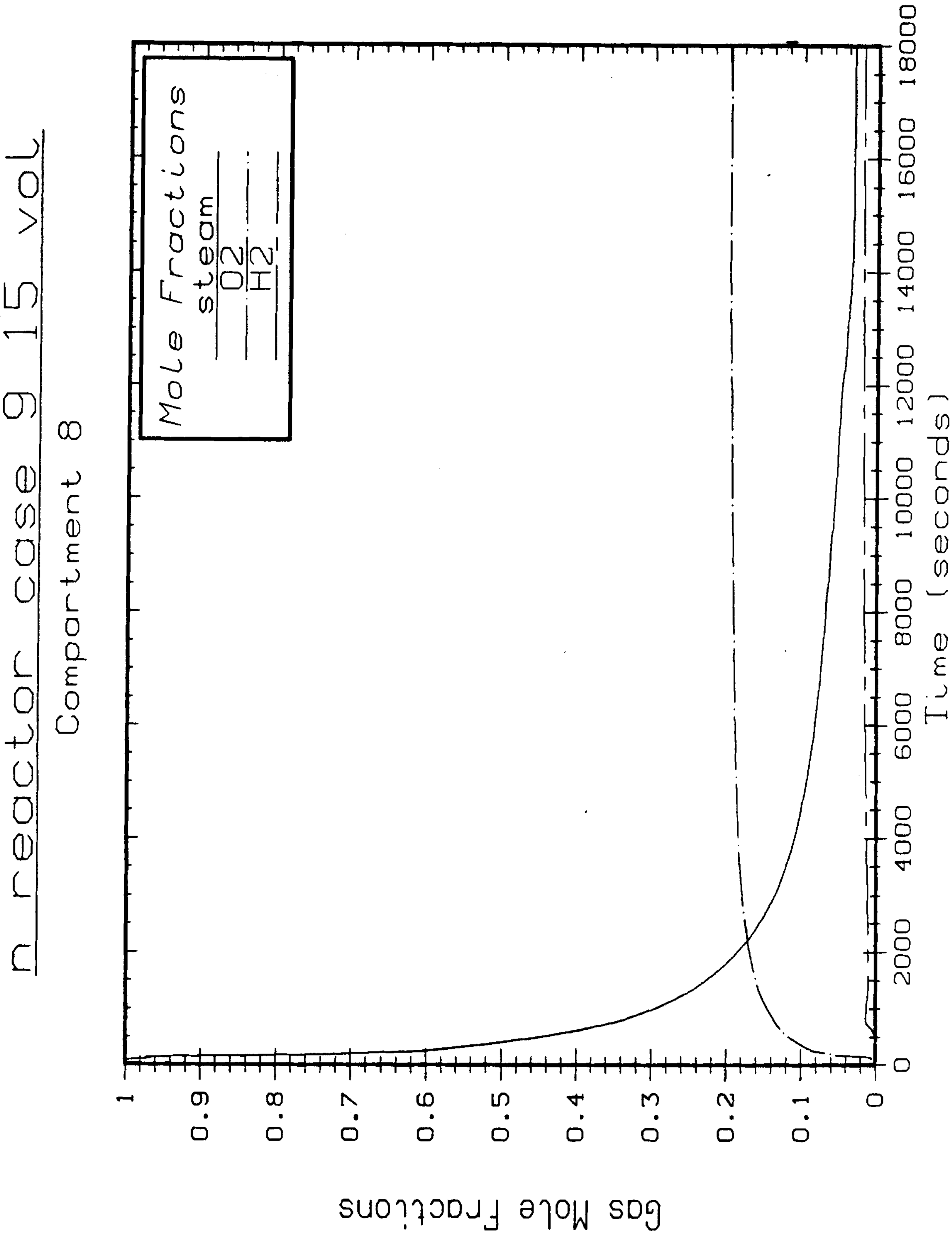


Figure 5.22. Case 9 Molar Concentrations in Volume 8 (18,000 s)

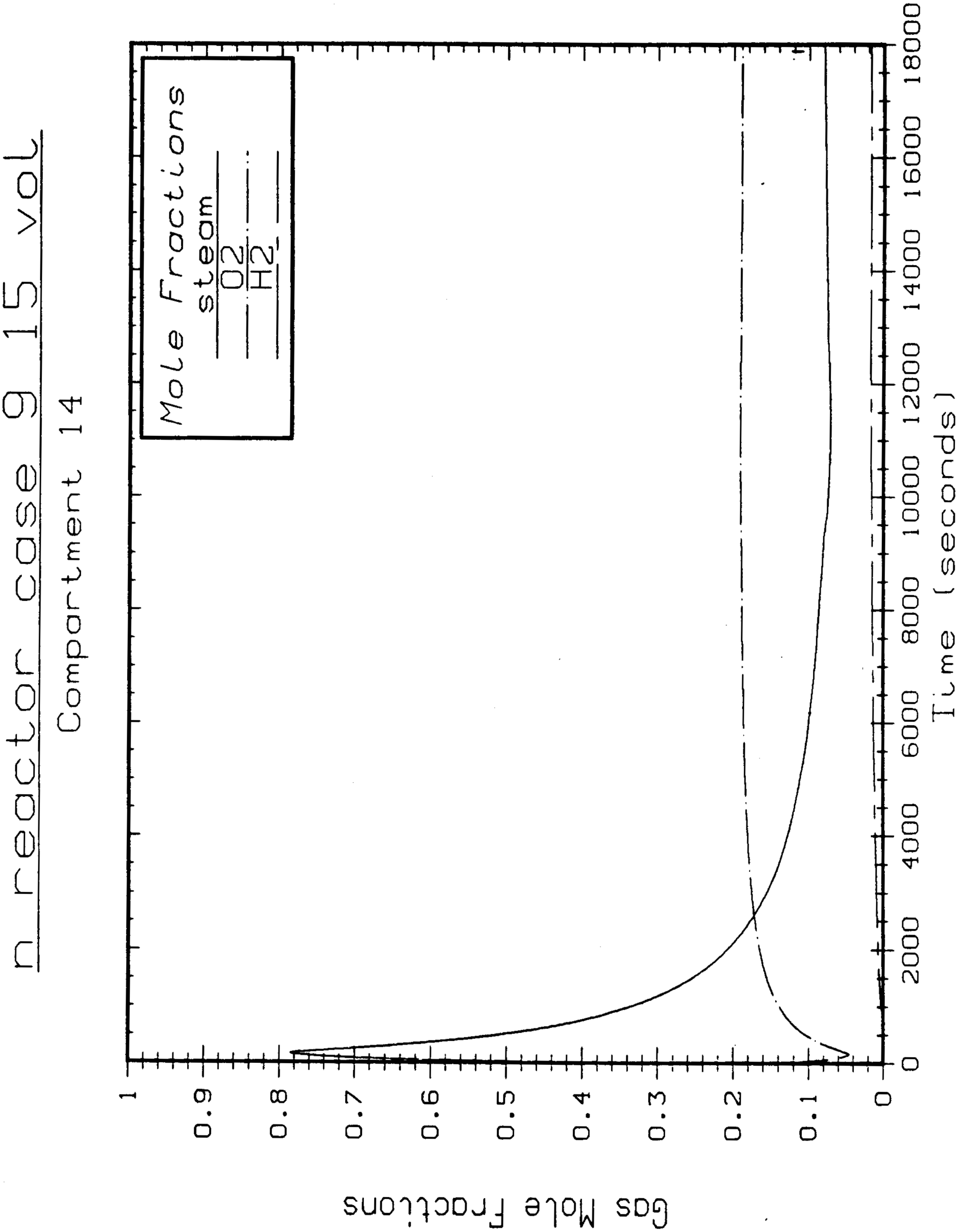


Figure 5.23. Case 9 Molar Concentrations in Volume 14 (18,000 s)

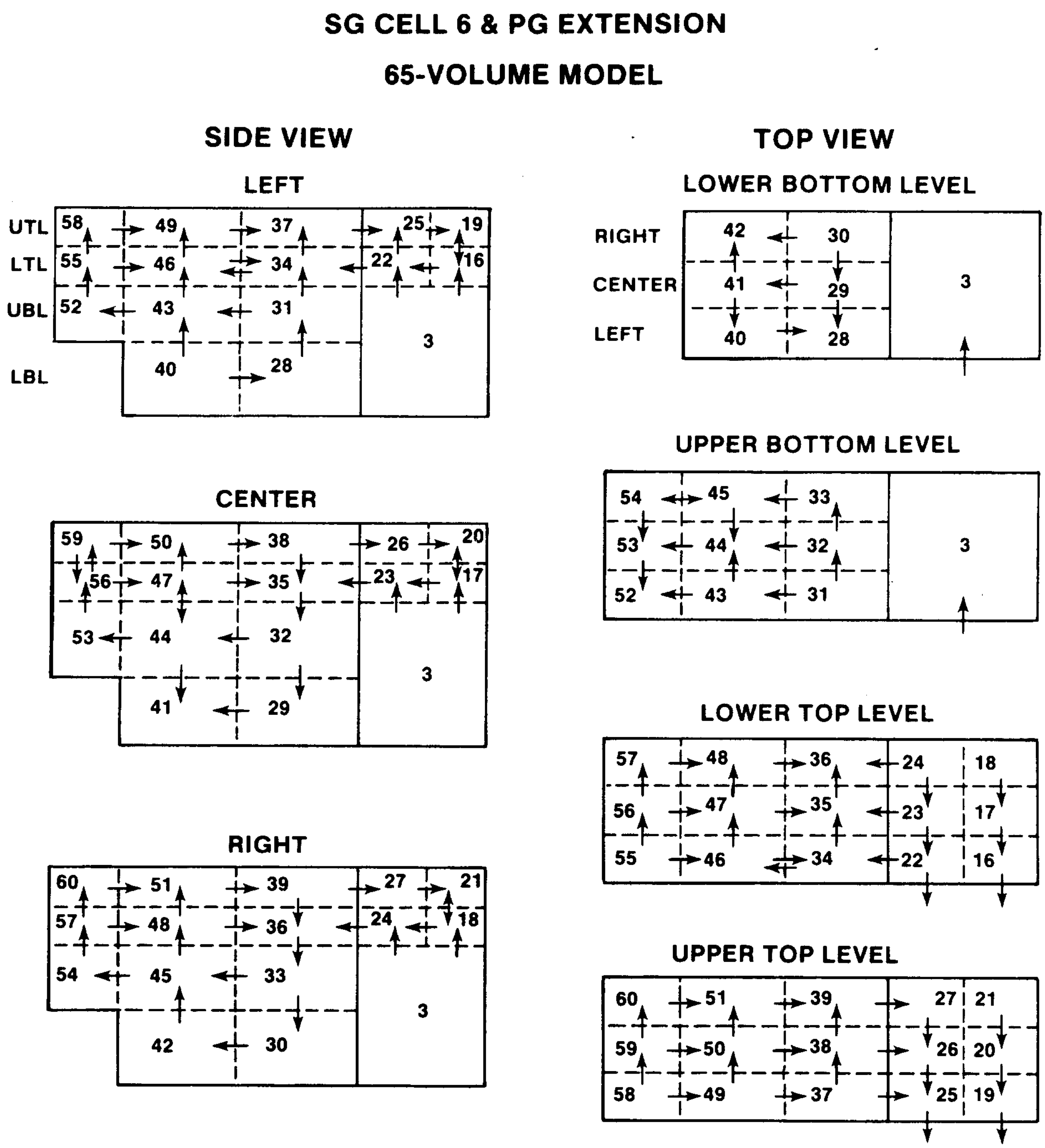


Figure 5.24. Case 10 Flow Patterns t > 800 sec

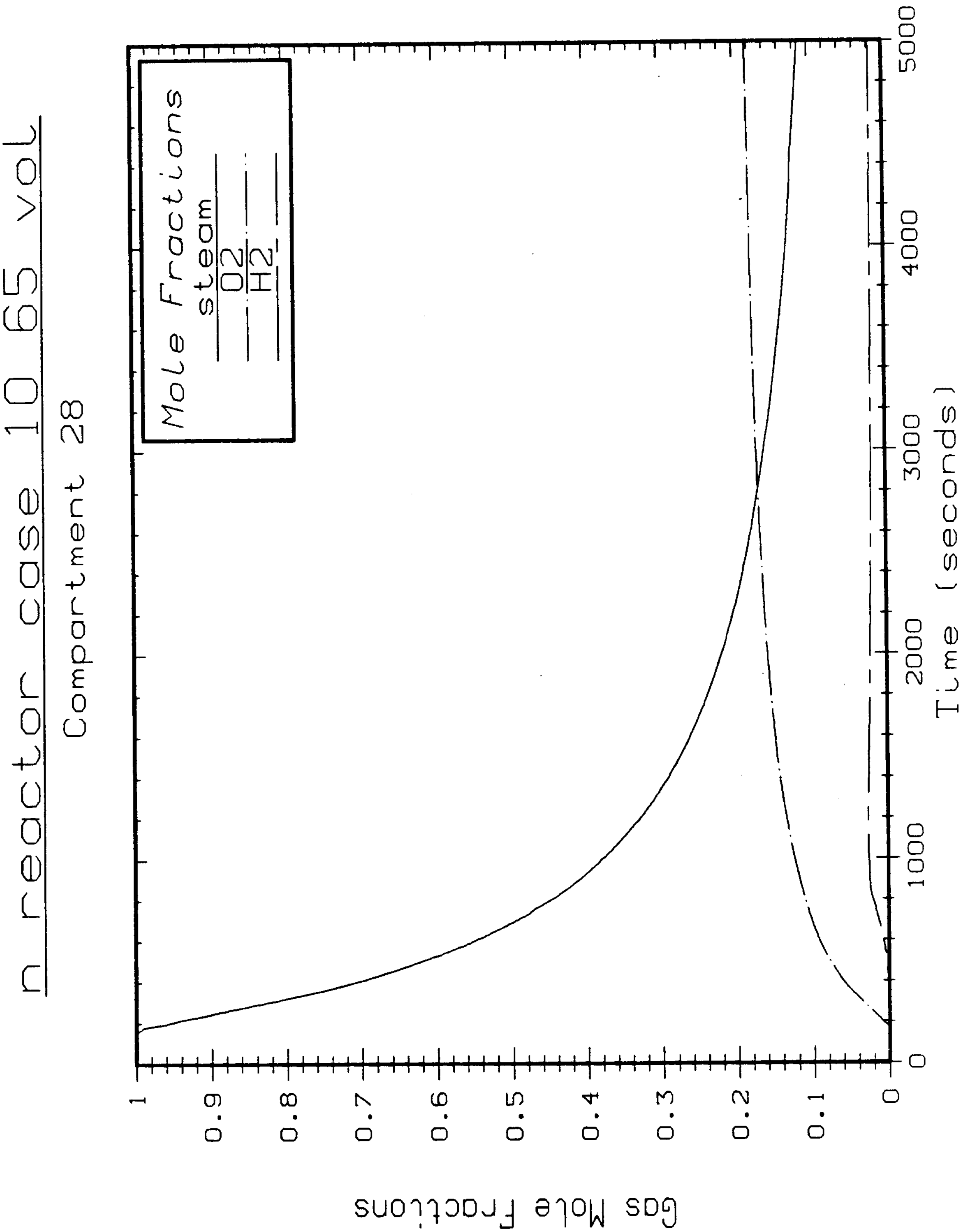


Figure 5.25. Case 10 Molar Concentrations in Volume 28

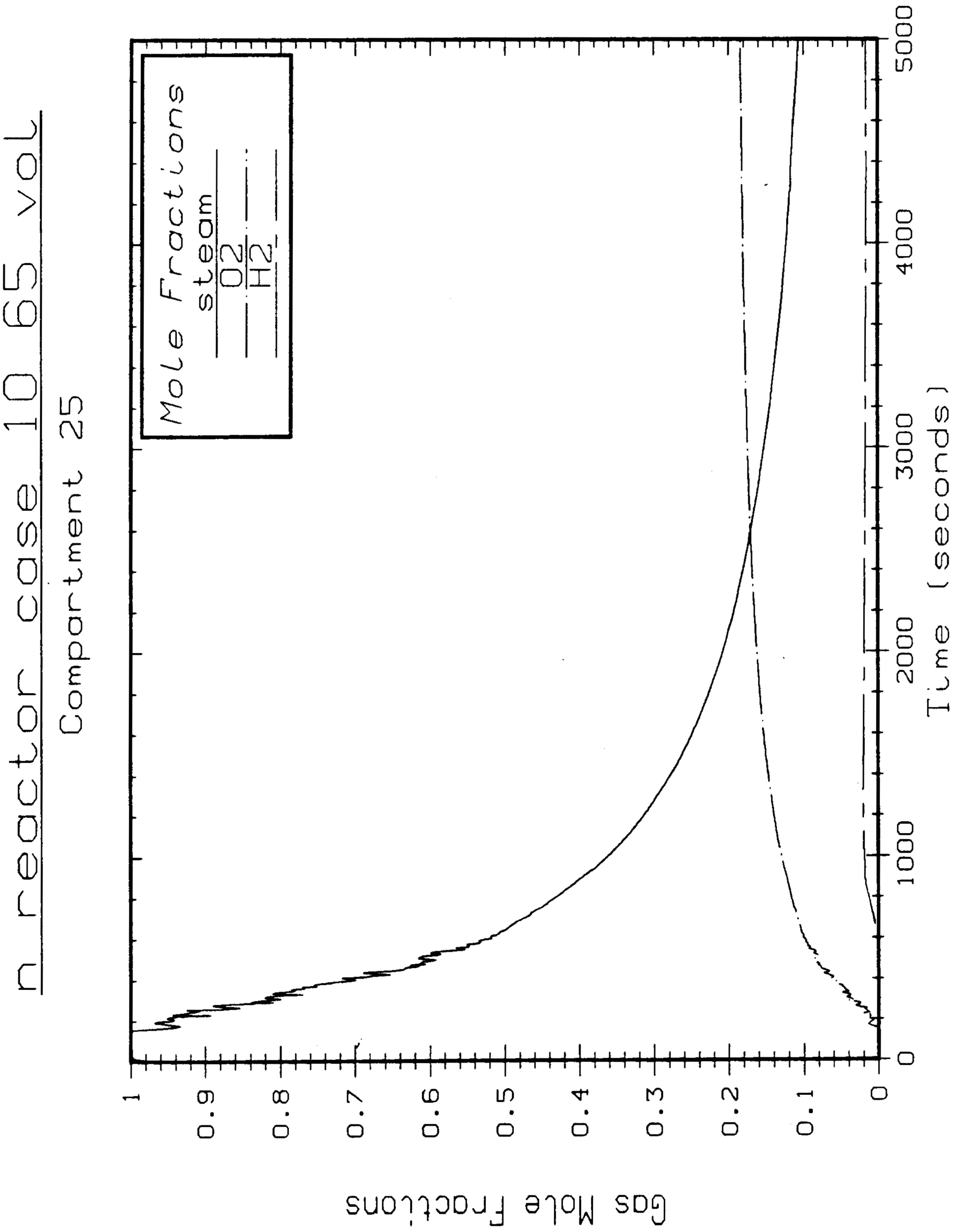


Figure 5.26. Case 10 Molar Concentrations in Volume 25

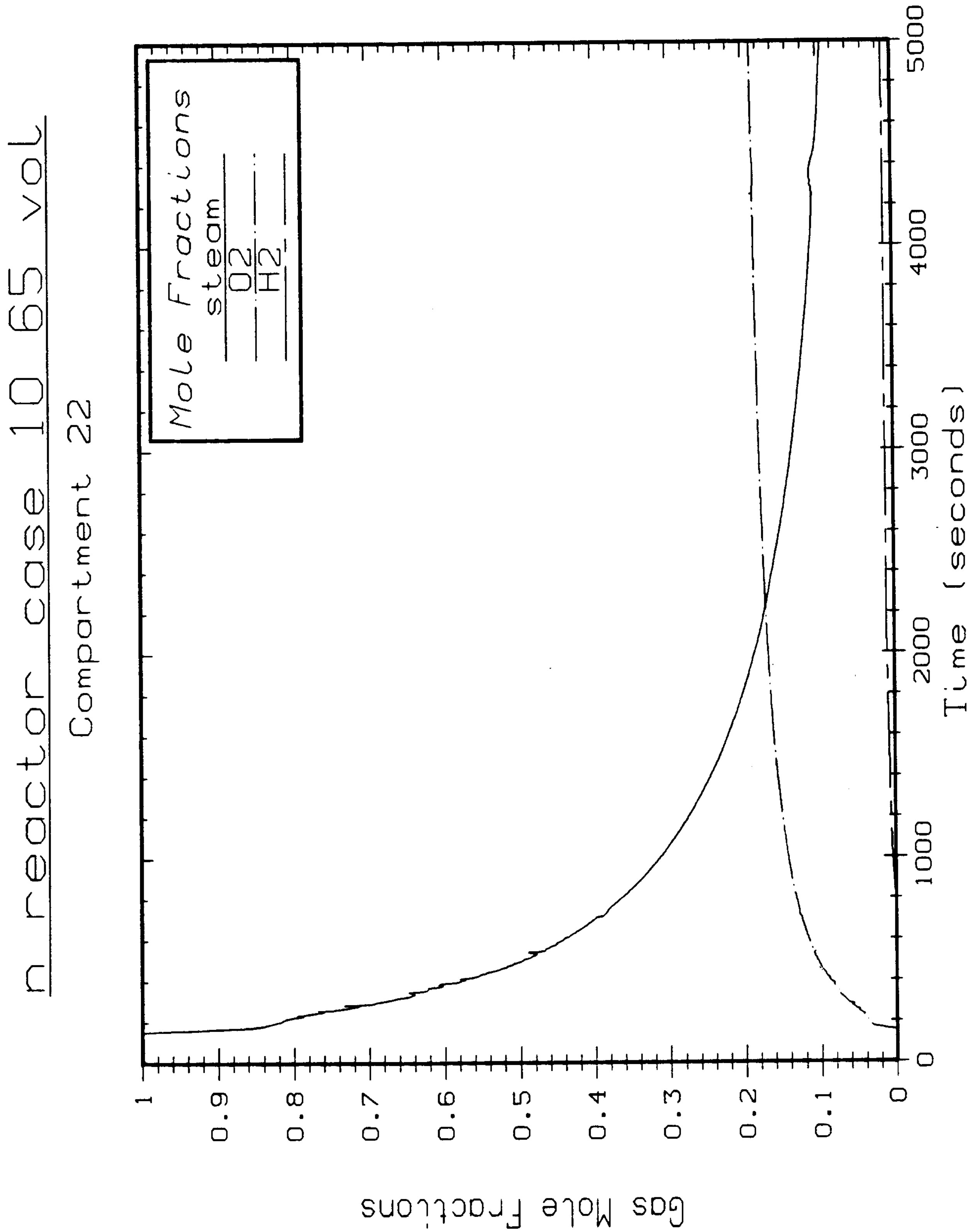


Figure 5.27. Case 10 Molar Concentrations in Volume 22

6. COMBUSTION RESPONSE IN THE 109 BUILDING

The parametric calculations have shown that hydrogen may mix throughout the 109 building for many cases involving hydrogen releases there. For example, cases 1, 2, and 3 all predicted initial gradients within the 109 building that disappear within several hundred seconds as the hydrogen mixes. These cases also predicted that very little hydrogen would be transported into the 105 building during the first few hours due to inflow of air from the filter building through the 105 building and into the 109 building. Because of this predicted behavior, we decided that it would be useful to examine the effects of combustion in the 109 building, assuming a uniform mixture throughout the 109 building.

These calculations were performed using the 5-compartment model previously discussed in Section 3.2.1. To reiterate, the 105 building is divided into compartments 1 and 2, the pipe gallery is compartment 3, the steam generator cells and auxiliary cell form compartment 4, and the filter building is compartment 5. In order to provide a somewhat conservative analysis, all leaks or vents to the outside atmosphere were assumed to be closed, including the junction between the reactor building and the filter building. Further, the sprays were inoperable for these calculations.

In all cases, the initial pressure within confinement was assumed to be 101.3 kPa (1 atm.). The temperature in the 109 building (compartments 3 and 4) was assumed to be 338.6 K (150°F), and the temperature in the 105 building (compartments 1 and 2) was assumed to be 321.9 K (120°F). 100% humidity was also assumed. Hydrogen was specified to be present in compartments 3 and 4 in equal concentrations, but no hydrogen was specified to be initially present in compartments 1 and 2. For a given amount of hydrogen and with the steam concentration determined by the temperature and humidity, the nitrogen and oxygen concentrations were adjusted in each case to maintain the initial pressure at 101.3 kPa (1 atm.) in each compartment.

Ignition was assumed to occur in compartment 3, with propagation into compartment 4 occurring at a later time. The default HECTR models were used for calculating propagation time, burn time, and burn completeness. These models are all described in Ref. 2. Unlike some of the assumptions discussed earlier, the HECTR burn models cannot be considered to be necessarily conservative. There is a significant amount of scatter in the experimental data for lean combustion, particularly with steam present, and these models produce reasonable, rather than bounding, values. Current evidence indicates that there are both conservative and nonconservative aspects of these models, and updated models are being developed.

The results are presented in Figures 6.1 through 6.3. Figure 6.1 provides a comparison between the HECTR predictions, the confinement design pressure, and the adiabatic, isochoric, complete combustion (AICC) values. The AICC values represent theoretical limits, assuming that dynamic pressure responses are not observed. Dynamic pressures will usually only occur for rich mixtures that produce flame speeds above Mach 0.1. The HECTR predictions shown in Figure 6.1 are far below the AICC values. The most important reason that the pressures are lower is that gas expansion into the 105 building occurs. Further, the burns are not adiabatic, with both convective and radiative heat transfer mechanisms at work. Finally, for burns below 8% hydrogen, the HECTR burn models predict incomplete combustion, ranging linearly from no combustion at about 4% hydrogen to complete combustion at 8% hydrogen. This accounts for the change in slope in the HECTR calculations at 8% hydrogen.

The most important modeling parameter in these calculations is the flame speed. HECTR calculates a flame speed that increases with hydrogen concentration and decreases with steam concentration. The burn time is determined by dividing the characteristic compartment dimension by the flame speed. The burn time determines the amount of time available for intercompartment venting and heat transfer. Venting not only allows gas expansion, but may also carry hydrogen to other compartments, where it may or may not participate in the combustion process. For all of the calculations presented here, the burns were of sufficient duration (several seconds) to allow pressure equilibration throughout the confinement. Relatively small amounts of hydrogen were pushed into the 105 building; these quantities were insufficient to allow propagation into the 105 building.

Figure 6.2 shows the HECTR calculations in more detail and using engineering units. Recall that these calculations assumed that the initial pressure was 101.3 kPa or 1 atm. In other situations the initial pressure may be different from this value. To a first approximation, the peak overpressure in other cases can be determined by assuming that the ratio of final to initial pressures is constant for a given percent hydrogen concentration. For example, at 5% hydrogen Figure 6.1 indicates that the ratio of final to initial pressures is approximately 136/101.3 or 1.34. If the initial pressure were increased 6.9 kPa (1 psi), then the final pressure would be 108.2 x 1.34 or 145 kPa (21.1 psia), and the peak overpressure on Figure 6.2 would be 44 kPa (6.4 psig). This approach should be considered very crude, as the heat transfer and gas flow characteristics will change for different gas mixtures. If a particular case is important, then a HECTR calculation should be performed; however, this approach does indicate the sensitivity of the results to the initial pressure.

Figure 6.3 shows the mass of hydrogen needed to produce the pressures shown in Figure 6.2. The abscissa of Figure 6.3 corresponds to the percent values in Figure 6.2, e.g., 558.6 lbm corresponds to 5% mole fraction of hydrogen. Note that a given mass of hydrogen burned (the figure shows the mass initially present, which is greater than or equal to the amount burned) will result in a given pressure increment, whereas a given hydrogen concentration will result in a given final to initial pressure ratio.

The results presented in this chapter should be used carefully. The calculations are useful for scoping purposes, but they do not represent any particular scenario. They do provide an indication of the mass of hydrogen that could be threatening to the integrity of the confinement in those cases where no venting to the outside occurs. While the sprays are not included in these calculations, they would have a modest impact on the results - probably 20% or less. The results indicate that combustion of quantities in the 109 building in the range of 500 - 700 lbm of hydrogen could threaten the confinement integrity. Given that this mass represents only 5 - 6% hydrogen, it would appear that deliberate ignition as a sole mitigation scheme would be of limited value, as it would be very difficult to assure ignition before hydrogen concentrations of 5 - 6% were reached.

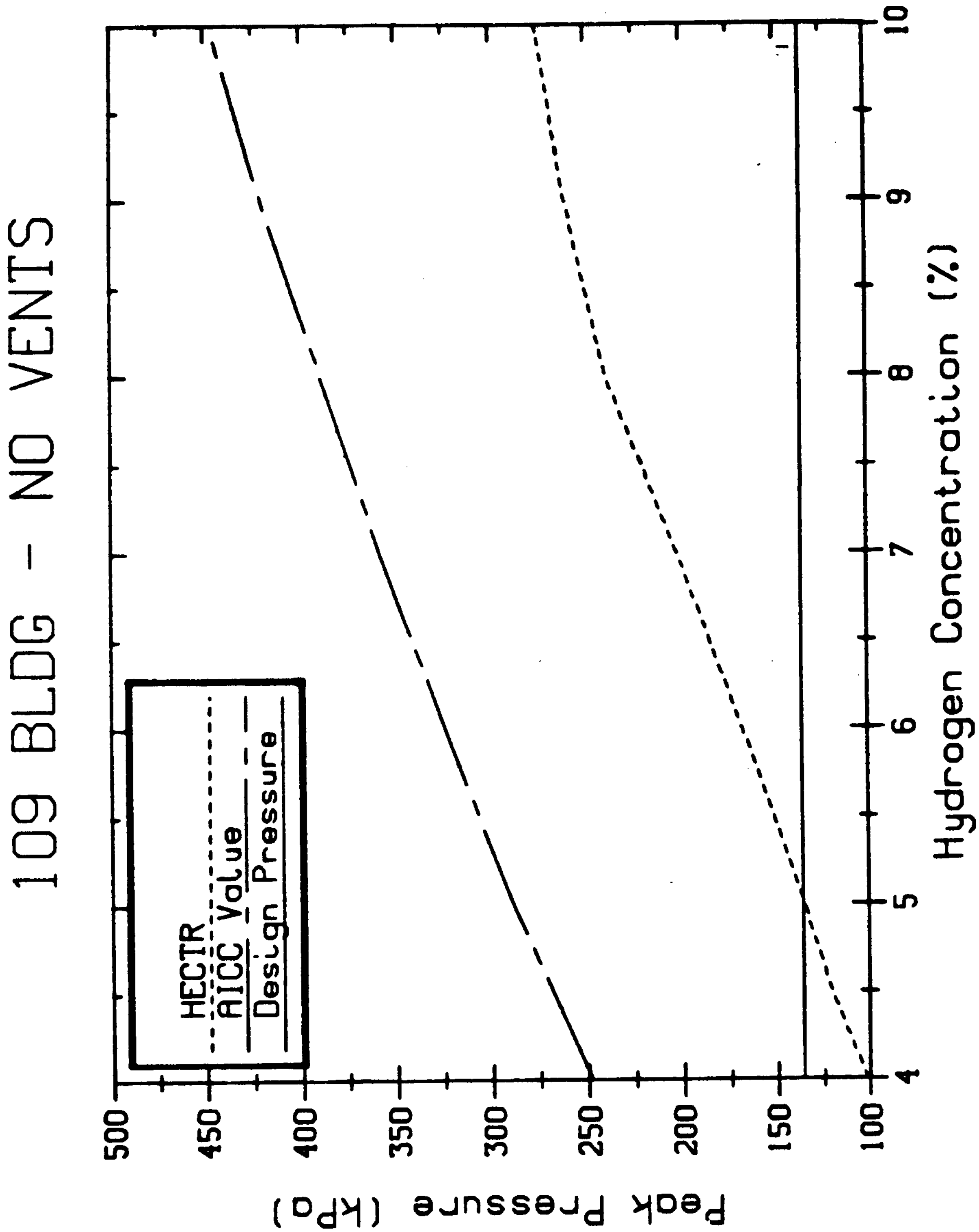


Figure 6.1. Comparison of HECTR Predictions to AICC for Peak Pressure

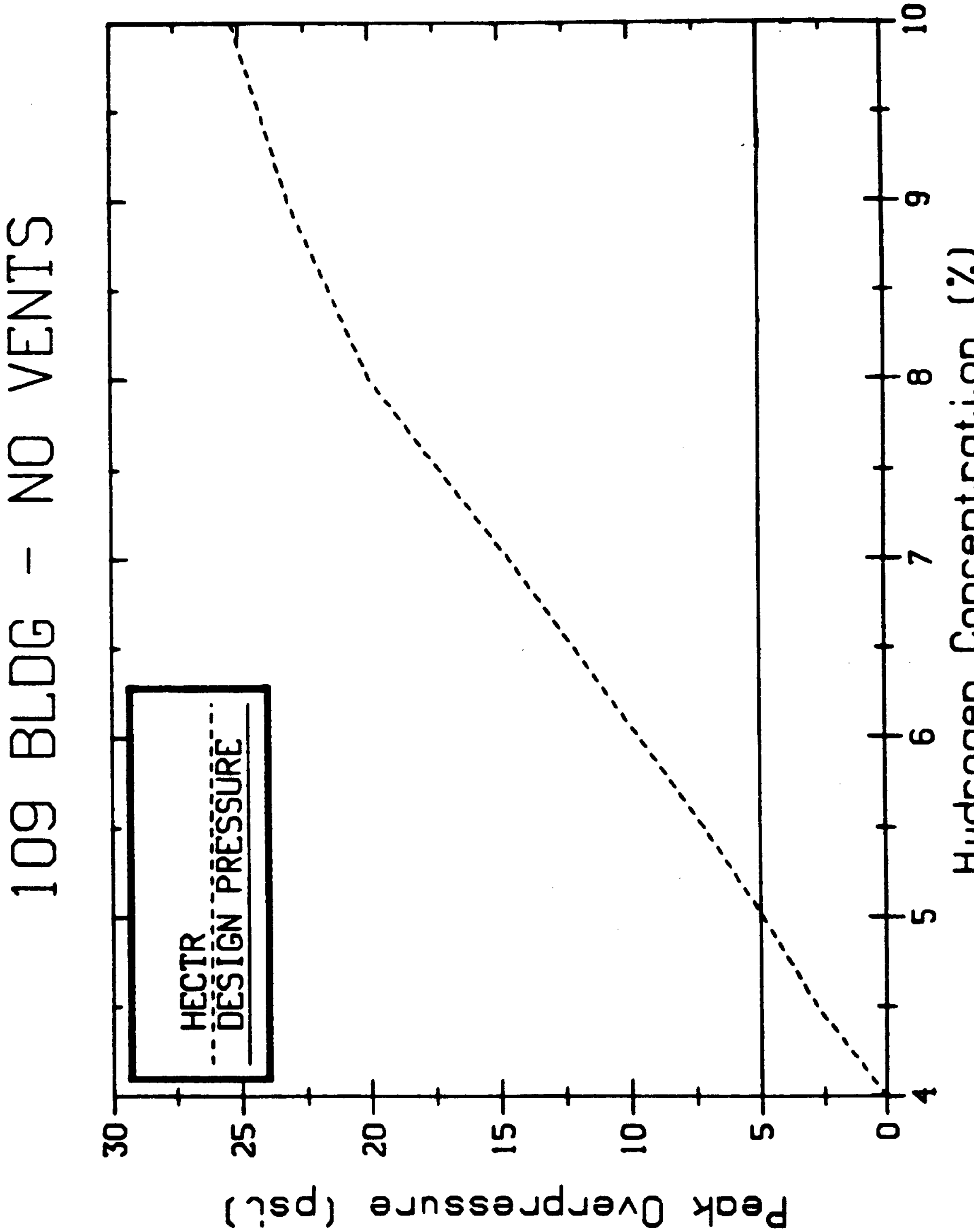


Figure 6.2. Peak Overpressure vs. Initial Hydrogen Concentration

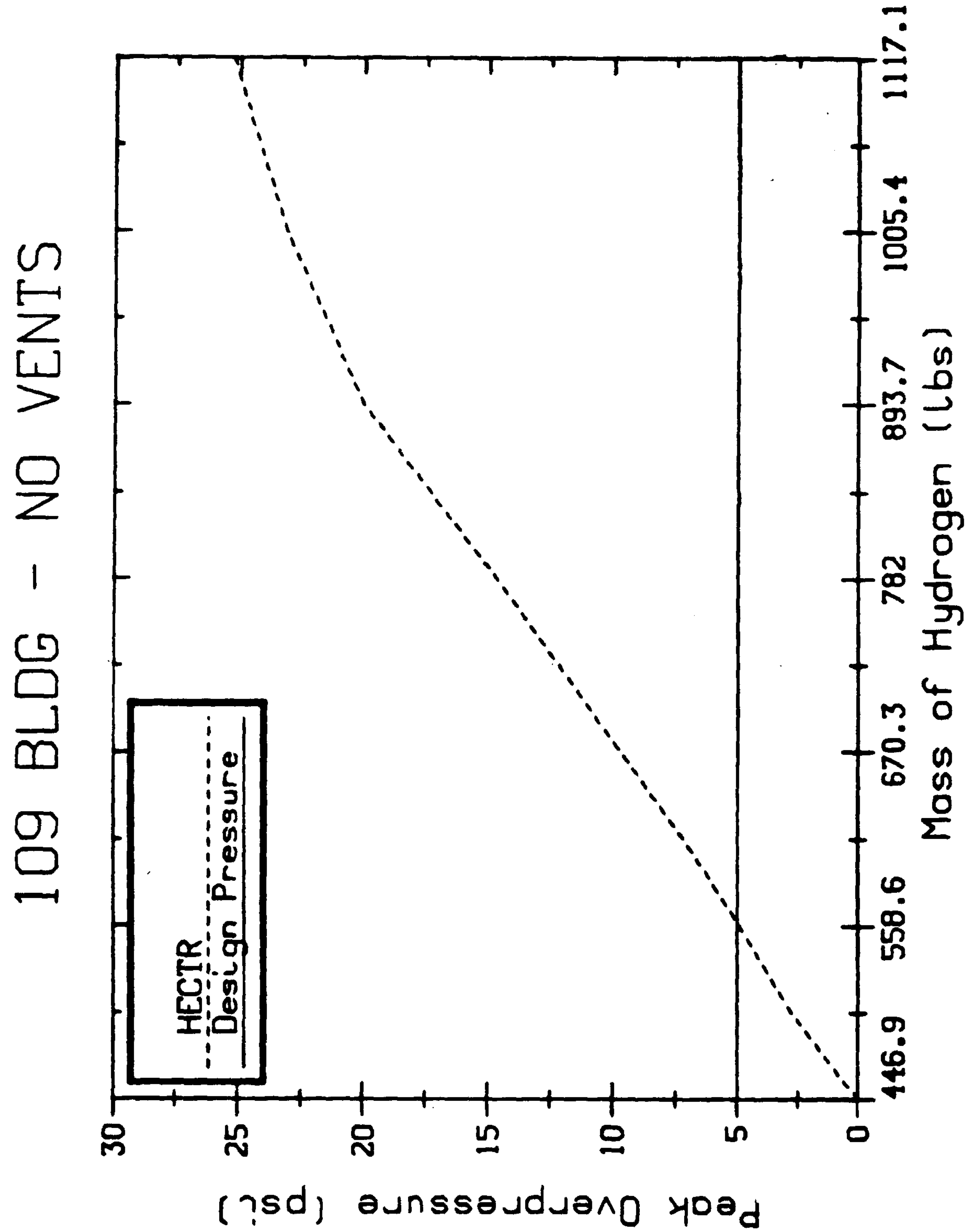


Figure 6.3. Peak Overpressure vs. Initial Hydrogen Mass

7. CONCLUSIONS

It is very difficult to draw general conclusions regarding hydrogen transport and combustion in the N Reactor confinement, due to the complexities of the confinement geometry and the associated flow paths. These complexities tend to make the results scenario-specific. Thirteen calculations of hydrogen transport were completed, some of which included combustion. Additional calculations were performed to examine combustion effects in the 109 building. These calculations are not representative of all possible scenarios, but do provide numerous insights that can guide the initial evaluation of the potential importance of hydrogen and the development of mitigation strategies, if they are found to be necessary. These calculations should be considered in the context of the overall safety evaluation effort for the N Reactor, which includes other hydrogen analyses plus analyses to identify potential dominant accident sequences. For example, some of the sequences analyzed in this study may be shown later to be probabilistically unimportant.

The calculations performed evaluated different compartmentalizations, several source locations, varying source rates, the effects of sprays, and the importance of operating the sump pumps in the 109 building. The 15 and 38 volume models produced similar results for releases in the pipe gallery; the differences would probably be more significant for other release locations. The 38 and 65-volume models predicted different results for releases within a steam generator cell. Significant accumulation of hydrogen in the cell, due to inadequate nodalization, was predicted in the 38-volume case. Hydrogen accumulation was predicted whenever the hydrogen was released into a dead-ended volume (the pressurizer penthouse, case 5). Varying the source rate by a factor of two had little effect, given a release into the pipe gallery. The sprays had modest effect for releases into the pipe gallery, with fairly rapid mixing occurring in either case. HECTR probably underestimates the mixing effects of the sprays, as turbulence and momentum effects are neglected.

We can draw some important conclusions regarding hydrogen transport from our calculations. The initial blowdown purges most of the air in the confinement by pushing the gas out through the steam vents. Following the initial blowdown, condensation of steam results in inflow of air through the vacuum breakers and the filter building. This inflow appears to turn around after a few hours, if the hydrogen source rate becomes larger than the condensation rate. None of the cases produced much hydrogen transport between the 105 and 109 buildings for the first few hours. Within each building, mixing was predicted to occur over a time frame of several hundred seconds with one important exception. Releases into the pressurizer penthouse were predicted to produce hydrogen accumulation within that room. Hydrogen flow out of this compartment was minimal due to the low flow rates and the influence of condensation. In fact, the condensation rate was sufficient to bring some oxygen back into the compartment.

The insights produced regarding hydrogen transport relate directly to potential combustion concerns. There are four potential combustion mechanisms to consider: continuous burning (temperature effect), local deflagrations, global deflagrations, or local detonations. Continuous burning was not addressed in this study, but depends on the source rate and conditions and the availability of an ignition source.

Calculations were performed that predicted mixtures that would sustain a local deflagration. These occurred for releases in the pipe barrier space or in a steam generator cell. A release in the pressurizer penthouse would also likely lead to locally flammable mixtures. The quantities of hydrogen released in the scenarios considered, 88 - 176 kg, are not sufficient to produce burn pressures above the confinement design limit of 136 kPa (5 psig), even if no venting of the confinement takes place. These conclusions should hold true for any burn location, provided that the preburn pressure is not significantly above 1 atm and the burns are sufficiently slow to allow pressure equilibration throughout the confinement. Pressure equilibration should occur for burns that are a few seconds or longer in duration, as the junctions connecting the different compartments are all relatively large.

Global deflagrations are those deflagrations that involve a significant fraction of the confinement volume, e.g., the 109 building. In order to produce a global deflagration, significantly more hydrogen is needed than was assumed in the transport calculations presented in this report. 176 kg of hydrogen mixed throughout the 109 building does not produce a flammable mixture. It is unlikely that any deflagration (global or local) produced as a result of these source term assumptions will threaten the confinement.

While continuous burning or deflagrations would appear to provide little threat to the confinement for the cases considered, accelerated flames and local detonations are another matter. Such events could occur quickly enough to preclude pressure equilibration throughout the confinement and could also produce dynamic, as well as static, pressure loads. Detonations have been sustained in experiments with hydrogen concentrations as low as ~13% and transition from a deflagration to a detonation has been observed a few percent higher [19].

The case involving the pressurizer penthouse predicted a very high hydrogen concentration; however, the penthouse was predicted to remain oxygen inerted over the length of the calculation. There are several difficulties in drawing conclusions about this case. First, the nodalization was probably insufficient to deal with mixing between the penthouse and the pipe gallery. Second, the calculation predicts large quantities of oxygen in the pipe gallery. Thus, we have oxygen-rich and hydrogen-rich regions located adjacent to one another. There is undoubtedly some mixing in the boundary region, and it is unlikely that flammable mixtures will not be formed at some point in time. Once combustion begins, induced gas flow will probably promote additional mixing between the two regions. In any case, a local detonation cannot be ruled out in this situation.

To summarize, quantities of hydrogen greater than those assumed in these scenarios would have to be present for deflagrations to be a major concern. Accelerated flames and local detonations may be a concern for hydrogen released into dead-ended volumes. Significant uncertainties remain in our results, including 1) the likely magnitude of hydrogen release given different source locations and accident sequences, 2) the probability of hydrogen releases in different locations, 3) the timing of ignition without a deliberate ignition system, 4) the inherent uncertainty in modeling gas transport with a lumped-parameter code, and 5) the likelihood of an accelerated flame or a local detonation in a given location with a given gas mixture.

8. REFERENCES

1. A. L. Camp, et al., HECTR Version 1.0 User's Manual, NUREG/CR-3913, SAND84-1522, Sandia National Laboratories, February 1985.

2. S. E. Dingman, et al., HECTR Version 1.5 User's Manual, NUREG/CR-4507, SAND86-0101, Sandia National Laboratories, April 1986.

3. C. L. Wheeler, M. J. Thurgood, T. E. Guidotti, and D. E. Bellis, COBRA-NC: A Thermal Hydraulic Code for Transient Analysis of Nuclear Reactor Components: Volume 4 User's Manual for Containment Analysis, NUREG/CR-3262, PNL-5515, Pacific Northwest Laboratories, Richland, WA, August 1986.

4. Hypothetical Accident Sequence (NUSAR, Chapter 15)(see Reference 6).

5. N Reactor Informal Notes (Notebooks) Misc.

    a. External NUSAR Hypothetical Accident Hydrogen Generation Rate and Quantity.

    b. Cold Leg Break MHA DC = 0.6 (straight)
    New Model (break flow and enthalpy)

    c. Contempt 4 N Reactor Input Model

    d. Notes containing details of calculations of all volumes; concrete and steel areas; junction areas, elevations, and loss coefficients; fog spray system locations, rates, and drop sizes.

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19. J. Lee, et al., "Hydrogen Air Detonations," Proceedings of the Second International Workshop on the Impact of Hydrogen on Water Reactor Safety, NUREG/CP-0038, EPRI RP1932-35, SAND82-2456, Albuquerque, NM, October 1982.

APPENDIX A

HECTR INPUT DATA

A.1 Introduction to Model Calculations

In this appendix, we show the details of the calculation of the physical parameters in the model. Originally, a rough calculation was done and then this more detailed one. There are some differences between the 5, 15, and 38-volume models as additional information was received and updated calculations were performed. We have attempted to note where any substantial difference occurred and why. None of these differences are large enough to make significant changes in the case results.

The following are the thermal properties and conversion factors used in this analysis. The material properties are from reference 4.

Thermal Properties in English Units

	Density (ρ)	Conductance (C)	Conductivity (K)	Specific Heat C_p	Heat Trans Coef(h)
304 steel	501	9.4	26.2	.127	.28
Concrete	146	1.05	1.38	.156	.28
English Units	$\frac{lbm}{ft^3}$	$\frac{btu}{hr\text{-}ft^2\text{-}°F}$	$\frac{btu}{hr\text{-}ft^2\text{-}°F}$	$\frac{btu}{lbm\text{-}°F}$	$\frac{btu}{hr\text{-}ft^2\text{-}°F}$

$$q = KA\frac{t_1-t_2}{\Delta x} = CA(t_1-t_2) \qquad \alpha = \frac{K}{\rho C_p}$$

Conversion Factors

For C,h $\quad 1\frac{BTU}{hr\text{-}ft^2\text{-}°F} = 5.6784\ \frac{W}{m^2\text{-}°C}$

For K $\quad 1\frac{BTU}{hr\text{-}ft\text{-}°F} = 1.7308\ \frac{W}{m°\text{-}C}$

For ρ $\quad 1\frac{lbm}{ft^3} = 16.018\ \frac{Kg}{m^3}$

For C_p $\quad 1\frac{BTU}{lbm\text{-}°F} = 4.1868x10^3\ \frac{J}{Kg\text{-}°C}$

1 lbm = 4.5359x10^{-1} Kg

1 ft = .3048 m

1 ft^2 = .0929 m^2

1 ft^3 = .02832 m^3

Thermal Properties in MKS Units

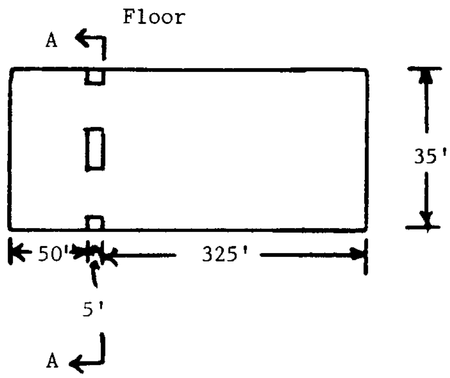
	ρ	C	K	C_p	h
304 Steel	8.03x60^3	53.38	45.35	531.7	1.59
Concrete	2.28x10^3	5.96	2.39	653.2	1.59

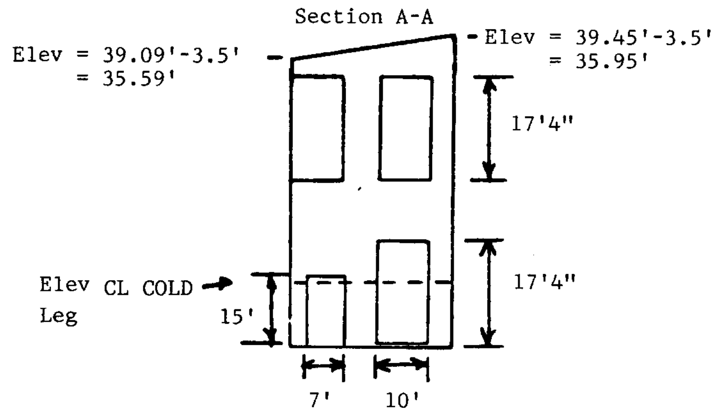
Therefore, in MKS Units	Concrete	Steel
C_p	653.2	531.7
ε	.9	.7
α	1.6E-6	1.06E-5
K	2.39	45.35

Assumed emissivity based on standard types of steel and concrete.

A.2 Calculation of Pipe Gallery Characteristics

1) Basic Calculation



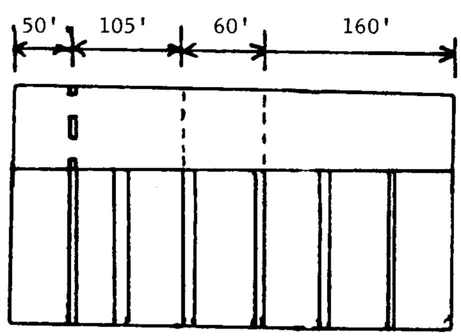


ave. ceiling ht. = (35.95' + 35.59')/2 = 35.77'

elevation of C_L cold leg = -1.5'

We will make compartments 20, 21, and 22 of detailed model (16'-1.5') = 14.5' high and divide the rest in half (16' + 35.77'-14.5')/2 = 27.27'/2 = 18.635'

Compartments 23, 24, 25, 26, 27, and 28 are 18.635' high



Compartments 22, 25, and 28 are 50'+5'+50'+5' = 160' long

Compartments 21, 24, and 27 are 5'+50'+5' = 60' long

Compartments 20, 23, and 26 are 5'+50'+5' = 105' long

a) Volumes

Volumes 22 = 160' x 35'x14.5' = 81,200 ft^3

Volumes 25,28 = 160'x35'x18.635' = 104,356 ft^3

Volumes 21 = 60'x35'x14.5' = 30,450 ft^3

Volumes 24,27 = 60'x35'x18.635' = 39,133.5 ft^3

Volumes 20 = 105'x35'x14.5' = 53,287.5 ft^3

Volumes 23,26 = 105'x35'x18.635' = 68,483.63 ft^3

Volumes 19 = 50'x35'x(35.77'+16') = 90,597.5 ft^3

Volumes 29 = 35'x26'x(83'9"-35.77') = 43,661.8 ft^3

b) Areas of Concrete/Sump/Junctions

<u>Volume 19</u>

A_{sump} = 510 ft^2

A_{conc} = 2x50'x51.77'+2x35'x51.77'+2x35'x50'

-513-(7'x15'+3x10'x17'4")-510 = 10,652.9 ft^2

SG Ducts Doors

junctions calculated in a) and SG cell (A.3).

<u>Volume 20</u>

A_{sump} = 1020 ft^2

A_{conc} = 35'x105'+2x105'x14.5'+35'x14.5'

- (7'x10')x14.5' - 1,020 = 5,961 ft^2

Doors

$A_{J20\to21}$ = 35'x14.5' = 507.5 ft^2 Elev = -8.75'

$A_{J20\to23}$ = 105'x35' = 3,675 ft^2 Elev = -1.5'

<u>Volume 21</u>

A_{sump} = 0 ft^2

A_{conc} = 60'x35'+2x60'x14.5' = 3,840 ft^2

$A_{J21\to22}$ = 35'x14.5' = 507.5 ft^2 Elev = -8.75'

$A_{J21\to24}$ = 60'x35' = 2,100 ft^2 Elev = -1.5'

<u>Volume 22</u>

A_{sump} = 1530 ft^2

A_{conc} = 160'x35'+2x160'x14.5'+35'x14.5'-1,530

= 9,217.5 ft^2

$A_{J22\to25}$ = 160'x35' = 5,600 ft^2 Elev = -1.5'

<u>**Volume 23**</u>

Doors

$$A_{conc} = 35'x18.635'-.5'x7'-10'x2.83'+105'x18.635'x2$$

$$= 4,533.74\ ft^2$$

$$A_{J23\to24} = 35'x18.635' = 652.23\ ft^2 \quad Elev = 7.82'$$

$$A_{J23\to26} = 105'x35' = 3,675\ ft^2 \quad Elev = 17.135'$$

<u>**Volume 24**</u>

Aux. Door

$$A_{conc} = 2x60'x18.635'-35' = 2,201.2\ ft^2$$

$$A_{J24\to25} = 35'x18.635' = 652.23\ ft^2 \quad Elev = 7.82'$$

$$A_{J24\to27} = 60'x35' = 2,100\ ft^2 \quad Elev = 17.135'$$

<u>**Volume 25**</u>

$$A_{conc} = 35'x18.635'+2x160'x18.635' = 6,615.43\ ft^2$$

$$A_{J25\to28} = 160'x35' = 5,600\ ft^2 \quad Elev = 17.135'$$

<u>**Volume 26**</u>

$$A_{conc} = 105'x35'+2x105'x18.635'+35'x18.635'$$

$$-2x513 -2x10'x17'4" = 6,867.91\ ft^2$$

SG Ducts Doors

$$A_{J26\to27} = 35'x18.635' = 652.23\ ft^2 \quad Elev = 26.45'$$

<u>**Volume 27**</u>

Aux.
Ducts Roof Prz Floor

$$A_{conc} = 2x60'x18.635'-513+60'x35'-35'x26'$$

$$= 2,913.2\ ft^2$$

$$A_{J27\to28} = 35'x18.635' = 652.23\ ft^2 \quad Elev = 26.45'$$

$$A_{J27\to29} = 35'x26' = 910\ ft^2 \quad Elev = 35.77'$$

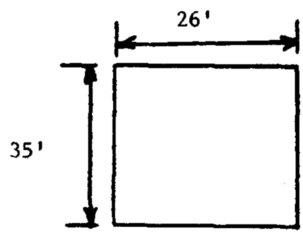
<u>Volume 28</u>

SG Ducts

$$A_{conc} = 35'\text{x}18.635'+160'\text{x}35'+2\text{x}160'\text{x}18.635'-3\text{x}513$$

$$= 10{,}676.43 \text{ ft}^2$$

<u>Volume 29</u> (Pressurizer)



Roof = 83' 9"

$$A_{conc} = 2\text{x}(35'+26')\text{x}(83'9"-35.77') + 35'\text{x}26' = 6{,}763.56 \text{ ft}^2$$

2) Doors from 19 → ?

$A_{J19\to20}$ = 7'x14.5'+10'x14.5' = 246.5 ft^2 Elev = -8.75 ft

$A_{J19\to23}$ = 0.5'x7'+10'x2.83' = 31.83 ft^2 Elev = -0.21 ft^2

$A_{J19\to26}$ = 2x10'x17'4" = 346.67 ft^2 Elev = 25.60 ft

Volume and Areas of Doors

Add to 19

Vol. = 1/2x(7'x15'+3x10'x17'4")x5 = 1,562.5 ft^3

Area = 1/2x(3x[17'4"+10']x2+2x(15'+7))x5' = 520 ft^2

Add to 20

Vol. = 1/2x14.5'x(7'+10')x5' = = 616.25 ft^3

Area = 1/2x[14.5'x4+7'+10']x5' = 187.5 ft^2

Add to 23

Vol. = 1/2x[0.5'x7'x5'+10'x5'x2.83'] = 79.58 ft^3

Area = 1/2x[2x0.5'+7'+2x2.83'+10']x5' = 59.17 ft^2

Add to 26

Vol. = 1/2x[2x10'x5'x17'4"] = 866.67 ft^3

Area = 1/2x[2x(17'4"+10')x2]x5' = 273.33 ft^2

3) <u>Crane Legs</u>

Crane legs are below elevation of SG cell ducts from NR_X notes. There are 46 legs with 23 in each row, one row on each side of the pipe gallery.

L row Vol. = 93.23 ft^3/leg area = 124.64 ft^2/leg

J row Vol. = 33.98 ft^3/leg area = 53.94 ft^2/leg

Subtract vol & add area of "x" legs to appropriate volumes

Vol. 19

Vol. = 4x(93.23+33.98) = 508.84 ft^3

Area = 4x(124.64+53.94) = 714.32 ft^2

Vol 23

Vol. = 6x(93.23+33.98) = 763.26 ft^3

Area = 6x(124.64+53.94) = 1,071.48 ft^2

Vol. 24

Vol. = 4x(93.23+33.98) = 508.84 ft^3

Area = 4x(124.64+53.94) = 714.32 ft^2

Vol. 25

Vol. = 9x(93.23+33.98) = 1,144.89 ft^3

Area = 9x(124.64+53.94) = 1,607.22 ft^2

4) Steel

NR_X Notes

Steel th(in)	Area (ft^2)
0.25	3,348
0.50	2,055
0.75	2,055
1.0	6,317
1.5	4,262
2.05	7,154
	25,191

Vol_{steel} = (0.25"x3348+0.5"x2,055+0.75"x2,055+

1.0"x6,317+1.5"x4,262+2.0+x7,154)x1/12"

= 2,535.31 ft^3

Mass = 501 lbm/ft^3 x 2,535.31 ft^3 = 1,270,191.56 lbm

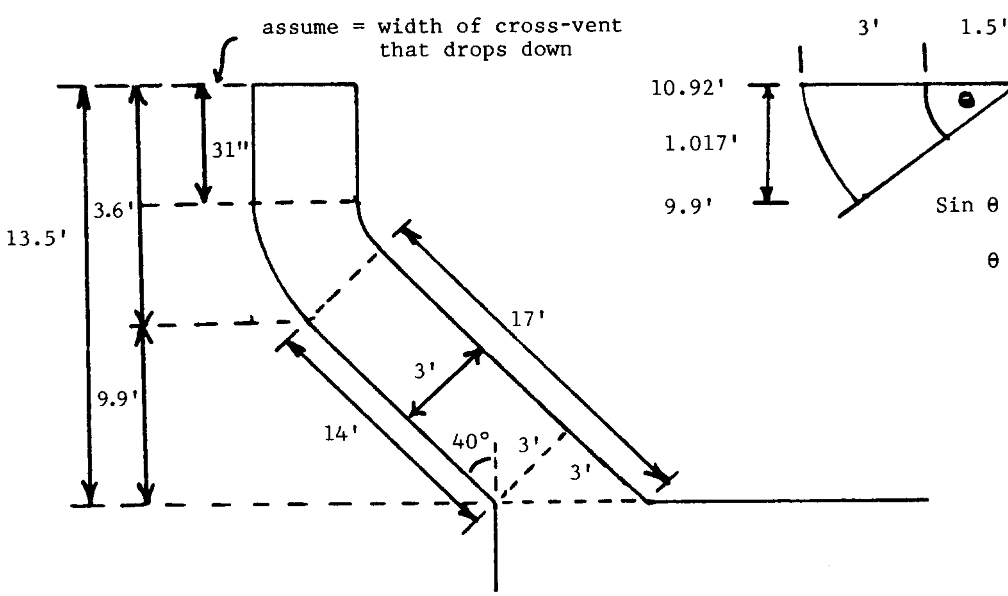
Most of the steel is below -1.5' elevation, then at top, and least in the middle.

Assume:	5% middle	1,259.56 ft^2	63,509.58 lbm
	10% top	2,5191.1 ft^2	127,019.16 lbm
	85% bottom	21,412,35 ft^2	1,079,662.83 lbm

Assume: ratio by volume & include Vol. 19 ~ 20+23+26

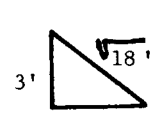
	Area (ft^2)	Mass (lbm)
19	3,358.80	169,358.87
20	5,995.46	302,305.59
21	3,425.98	172,746.05
22	9,135.94	460,656.14
23	352.67	17,782.68
24	201.53	10,161.53
25	537.41	27,097.42
26	705.35	35,565.37
27	403.06	20,323.07
28	1,074.82	54,194.84

5) Eight Ducts to R_x Bldg. from 26, and 28 (4 in each)



$\sin\theta = \frac{1.017'}{4.5'}$

θ = .228 radians
= 13.06°



45° Triangle

A_{side} = 1/2 x 3'x3'+3'x14'+1/2x[$4.5^2 - 1.5^2$]x0.228 +

3'x(31/12)' = 5,630 ft^2

Vol = 56.30'x (102/12)'x4 = 1,914.27 ft^3/side

For each side have 4 ducts each 102" wide

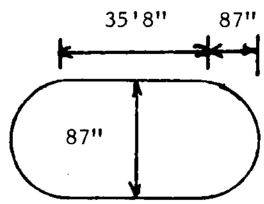
A_{conc} = 4x[2x(31/12)'x(102/12)'+14'x(102/12)'

+ 17'x(102/12)'+2x56.30+(102/12)'x4.5'x0.228+1.5'

x 0.228x(102/12)'] = 1,726.56 ft^2

Add to volumes 26 and 28

6) Pressurizer



$$V = 4/3 \times \pi \times (87/2\times12)^3 + \pi \times (87/2\times12)^2 \times 35'8" = 1{,}671.94\ ft^3$$

7) Summary of PG Volumes

<u>Vol. 19</u>

$$V_{19} = 90{,}597.5 + \overset{\text{Doors}}{1{,}562.5} + \overset{\text{Ducts}}{1{,}282.5} + \overset{\text{Sump}}{4{,}142.71} \overset{\text{Crane Legs}}{-508.84}$$

$$= 97{,}076.37\ ft^3$$

$$A_{conc} = 10{,}652.9 + \overset{\text{Door Walls}}{520} + \overset{\text{Duct Walls}}{392.5} + \overset{\text{Sump Ceil}}{110} + \overset{\text{Crane Legs}}{714.32}$$
$$= 12{,}389.72\ ft^2$$

Flame Propagation Length = 51.77'/2 = 25.89 ft

Elev CL vol. 19 = 9.89 ft

$A_{J19\rightarrow30}$ = 513 ft^2 Elev = 27.28 ft

$A_{JS19\rightarrow30}$ = 436.33 ft^2 Elev = -20.96 ft

$A_{J19\rightarrow20}$ = 246.5 ft^2 Elev = -8.75 ft

$A_{J19\rightarrow23}$ = 31.83 ft^2 Elev = -0.21 ft

$A_{J19 \to 26}$ = 346.67 ft^2 Elev = 25.60 ft

A steel = 3,358.80 ft^2

M steel = 169,358.87 ft^2

Characteristic Length = 51.77 ft

A_{sump} = 510 ft^2

<u>Vol. 20</u>

$$V_{20} = 53{,}287.5+\underbrace{616.25}_{\text{Doors}}+2\text{x}4142.71 = 62{,}189.17\ ft^3$$

$$A_{conc} = 5{,}961+\underbrace{187.5}_{\text{Doors}}+\underbrace{2\text{x}110}_{\text{Sump Ceil}} = 6{,}368.5\ ft^2$$

Flame Propagation Length = 105'/2 = 52.5 ft

$Elev_{CL}$ Vol. 20 = -8.75 ft

A_{steel} = 5,995.46 ft^2

M_{steel} = 302,305.59 lbm

Characteristic Length = 14.5 ft

A_{sump} = 1,020 ft^2

$A_{J20 \to 21}$ = 507.5 ft^2 Elev = -8.75 ft

$A_{J20 \to 23}$ = 3.675 ft^2 Elev = -1.5 ft

<u>Vol 21</u>

V_{21} = 30,450 ft^3

A_{conc} = 3,840 ft^2

Flame Propagation Length = 60'/2 = 30 ft

$Elev_{CL}$ vol. 21 = -8.75 ft

A_{steel} = 3,425.98 ft^2

M_{steel} = 172,746.05 lbm

Characteristic length = 14.5 ft

Asump = 0

$A_{J21 \to 22} = 507.5\ ft^2$ Elev = -8.75 ft

$A_{J21 \to 24} = 2,100\ ft^2$ Elev = -1.5 ft

<u>Vol. 22</u>

$V_{22} = 81,200\ ft^3 + 3x4,142.71 = 93,628.13\ ft^3$

$A_{conc} = 9,217.5 + \overset{\text{Sump Ceil}}{3x110} = 9,547.5\ ft^2$

$A_{sump} = 1,530\ ft^2$

Flame Propagation Length = 160'/2 = 80 ft

$Elev_{CL}$ Vol. 22 = -8.75 ft

$A_{steel} = 9,135.94\ ft^2$

$M_{steel} = 460,656.14$ lbm

Characteristic Length = 14.5 ft

$A_{J22 \to 25} = 5,600\ ft^2$ Elev = -1.5 ft

<u>Vol. 23</u>

$V_{23} = 68,483.63 + \overset{\text{Doors}}{79.58} - \overset{\text{Crane Legs}}{763.26} = 67,799.95\ ft^3$

$A_{conc} = 4,533.74+59.14 + 1,071.48 = 5,664.39\ ft^2$

Flame Propagation Length = 105'/2 = 52.5 ft

$Elev_{CL}$ VOL 23 = 7.82 ft.

$A_{steel} = 352.67\ ft^2$

$M_{steel} = 17,782.68$ lbm

Characteristic Length = 18.635 ft

$A_{J23 \to 24} = 652.23\ ft^2$ Elev = 7.82 ft

$A_{J23 \to 26} = 3.675\ ft^2$ Elev = 17.135 ft

<u>Vol. 24</u>

$V_{24} = 39,133.5 + \overset{\text{Aux. Door}}{87.5} - \overset{\text{Crane Legs}}{508.84} = 38,712.16\ ft^3$

$A_{conc} = 2{,}201.2 + 60 + 714.32 = 2{,}975.52\ ft^2$

Flame Propagation Length = 60'/2 = 30 ft

$Elev_{CL\ VOL}\ 24 = 7.82\ ft$

$A_{steel} = 201.53\ ft^2$

$M_{steel} = 10{,}161.53\ lbm$

Characteristic Length = 18.635 ft

$A_{J24 \rightarrow 25} = 652.23\ ft^2$ Elev = 7.82 ft

$A_{J24 \rightarrow 27} = 2{,}100\ ft^2$ Elev = 17.135 ft

Vol. 25

$$V_{25} = 104{,}356 - \overset{\text{Crane Legs}}{1{,}144.89} = 103{,}211.11\ ft^3$$

$A_{conc} = 6{,}615.43 + 1{,}607.22 = 8{,}222.65\ ft^2$

Flame Propagation Length = 160'/2 = 80 ft

$Elev_{CL\ VOL}\ 25 = 7.82\ ft$

$A_{steel} = 537.41\ ft^2$

$M_{steel} = 27{,}097.42\ lbm$

Characteristic Length = 18.635 ft

$A_{J25 \rightarrow 28} = 5{,}600\ ft^2$ Elev = 17.135 ft

Vol. 26

$$V_{26} = 68{,}483.63 + \overset{\text{Doors}}{866.67} + \overset{\text{Rx Bldg Ducts}}{1{,}914.27} + 2 \times \overset{\text{SG Ducts}}{1{,}282.5}$$

$$= 73{,}829{,}57\ ft^3$$

$$A_{conc} = 6{,}867.91 + 273.33 + 1{,}726.56 + 2x392.5$$

$$= 9{,}652.8\ ft^2$$

Flame Propagation Length = 105'/2 = 52.5 ft

$Elev_{CL\ VOL}\ 26 = 26.45\ ft$

A_{steel} = 705.35 ft^2

M_{steel} = 35,565.37 lbm

Characteristic Length = 18.635 ft

$A_{J26 \to 27}$ = 652.23 ft^2 Elev = 26.45 ft

<u>Vol. 27</u>

$$V_{27} = 39{,}133.5 + \overset{\text{SG Ducts}}{1{,}282.5} = 40{,}416\ ft^3$$

A_{conc} = 2,913.2 + 392.5 = 3,305.7 ft^2

$A_{J27 \to 28}$ = 652.23 ft^2 Elev = 26.45 ft

$A_{J27 \to 29}$ = 910 ft^2 Elev = 35.77 ft

A_{steel} = 403.06 ft^2

M_{steel} = 20,323.07 lbm

Characteristic Length = 18.635 ft

$Elev_{CL\ VOL}$ 27 = 26.45 ft

Flame Propagation Length = 60'/2 = 30 ft

<u>Vol. 28</u>

$$V_{28} = 104{,}356 + \overset{\text{R}_x\text{ Bldg Ducts}}{1{,}914.27} + \overset{\text{SG Ducts}}{3x1{,}282.5} = 110{,}117.77\ ft^3$$

A_{conc} = 10,676.43 + 1,726.56 + 3x392.5 = 13,580.49 ft^2

A_{steel} = 1,074.82 ft^2

M_{steel} = 54,194.84 lbm

Flame Propagation Length = 160'/2 = 80 ft

Characteristic Length = 18.635 ft

$Elev_{CL\ VOL}$ 28 = 26.45 ft

<u>Vol. 29</u>

V_{29} = 43,661.8 - 1,671.94 = 41,989.86 ft^3

A_{conc} = 6,763.56 ft^2 (in original calculations left out roof so A_{conc} = 5,853.56 ft^2 in HECTR decks)

A_{steel} = 0

M_{steel} = 0

Flame Propagation Length = 47.98'/2 = 24 ft

$Elev_{CL\ VOL}$ 29 = 59.76 ft.

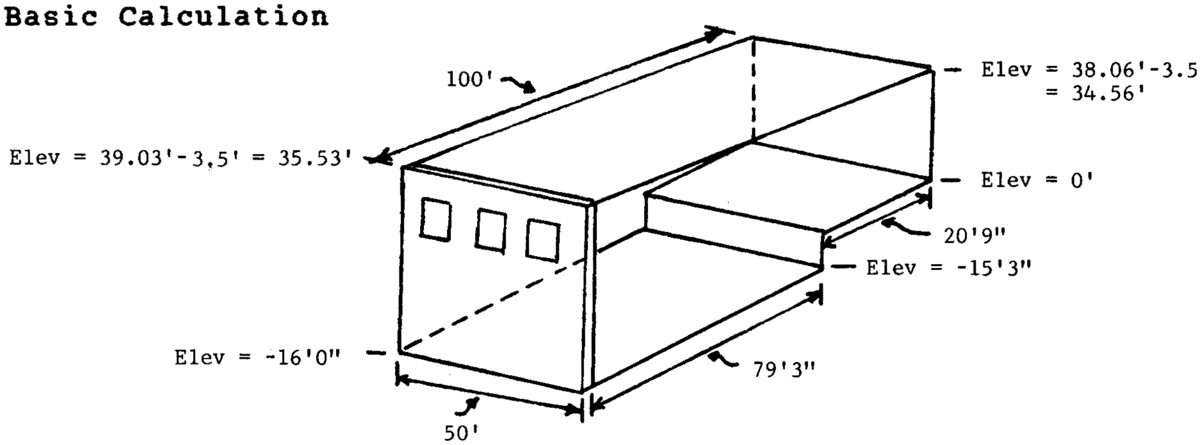
Comparison

	New	NR_X Notes	Contempt
Volume	759,420.09	723,343	721,671
A_{conc}	81,40083	76,107	62,178

Differences are due to including 105 vents, sump volume & area, 1/2 of junction volumes to other rooms, otherwise agrees with CONTEMPT volume. Back-calculating, our comparable area would be 77,540 ft^2.

A.3 Calculation of Steam Generator Cell Characteristics

1) Basic Calculation



$$Vol_o = 50' \times 79'\ 3" \times (16'+15'3")/2 +$$
$$100' \times 50' \times (35.53'+34.56')/2$$
$$= 237{,}139.06\ ft^3$$

$$A_{Ceil} = A_{Floor} = 50' \times 100' = 5{,}000\ ft^2$$

$$A_{Wall} = 2 \times 79'3" \times (16'+15'3")/2 + 2 \times 100'$$
$$\times (35.53'+34.56')/2$$
$$+ 50' \times 34.56'+50' \times 35.53'+50' \times 15'3"+50' \times 16'$$
$$= 14{,}552.56\ ft^2$$

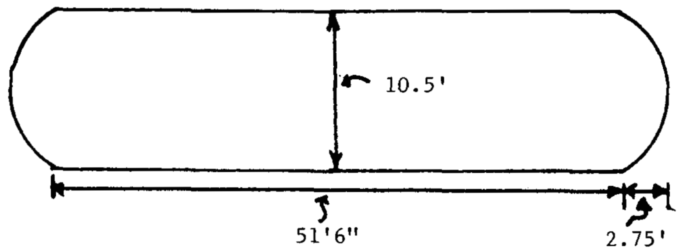
$$A_{Total} = 14{,}552.56\ ft^2+10{,}000\ ft^2 = 24{,}552.56\ ft^2$$

Elev. CL Duct = 35.53 -(18/12)'-13.5'/2 = 27.28 ft

(i.e., ducts 18" from roof and 13.5' high)

In the NRx notes, the volume and area calculations used different assumptions about the ceiling elevation. Upon comparison with the pipe gallery calculations, it was decided that the elevations for the roof are the external elevations and 3.5 ft must be subtracted to get the internal height for the calculations.

2) Volume of steam generators (2/cell) (NR_x notes)



Vol = L x π x r^2 + 4/3 x π x r^2 x a spheroid

= 51.5' x π x $(10.5'/2)^2$ +4/3 x π x $(10.5'/2)^2$ x2.75'

= 4,459.39 + 317.50

= 4,776.89 ft^3

Do not calculate surface area (included in steel)

Vol_2 steam generators/room = 9,553.78 ft^3

(subtract from volume of SG cell)

3) Volume of steam generator pedestals (2/steam generator) (NR_x notes)

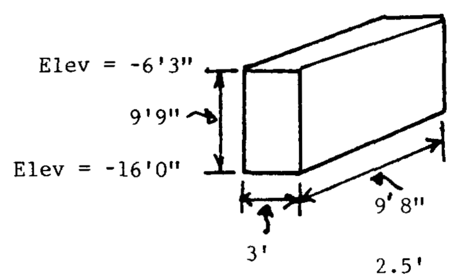
a) North pedestal

Height = 16'0"-6'3" = 9'9"

Vol = 3' x 9'8" x 9'9" = 282.75 ft^3

Vol 2 NPs = 565.5 ft^3

(Subtract from volume of SG cell)

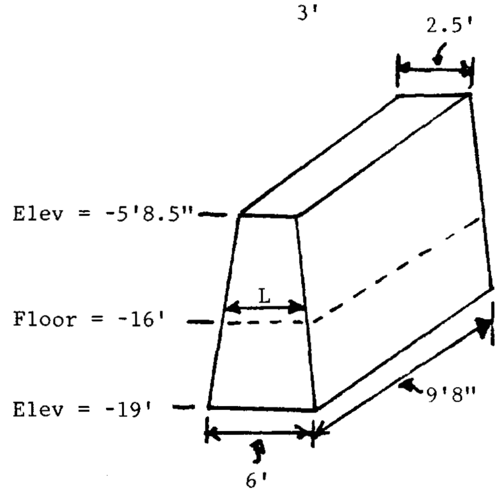


b) South pedestal

Pedestal is embedded in floor

L = 2.5' +((6'-2.5')/(19'-5.71'))x (16'-5.71') = 5.21 ft

Vol = 1/2 x (a+b) x h x ℓ



Vol = 9'8" x ((2.5'+5.21')/2)x(16'-5.71')

= 383.52 ft^3

Vol_{2SP} = 767.04 ft^3

(Subtract from vol. one of SG cell)

4) Areas of pedestals (NR_x notes)

a) North pedestal

Wall = 2x(3'+9'8")x(9'9") = 247 ft^2

Assume: since steam generator covers top of pedestal, subtract top from concrete area

A_{top} = 3' x 9'8" = 29 ft^2

A_{2NP} = 2 x (247-29) = 436 ft^2 (add to conc area)

b) South pedestal

Assume: since steam generator covers top of pedestal, subtract top from concrete area

A_{top} = 2.5' x 9'8" = 24.17 ft^2

Vertical wall = ends + sides

= 2 x 9'8" x (16'-5.71')+2 x ((5.21'+2.5')/2)

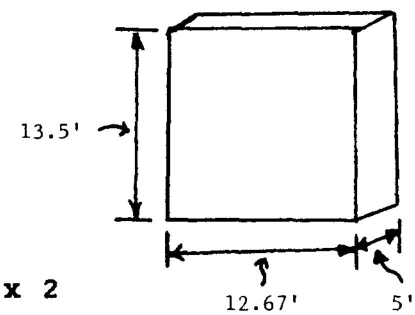
x (16'-5.71')

= 278.32 ft^2

A_{2SP} = 2x(278.32-24.17) = 508.32 ft^2 (add to conc area)

5) Duct volume/area (3/SG cell)

Include 1/2 of duct volume and side areas in SG cell



Vol_d = 1/2 x 5' x 13.5' x 12.67' x 3

= 1,282.5 ft^2

A_d=A_{W+T+B}=3 x 1/2 x (13.5'+12.67') x 5' x 2

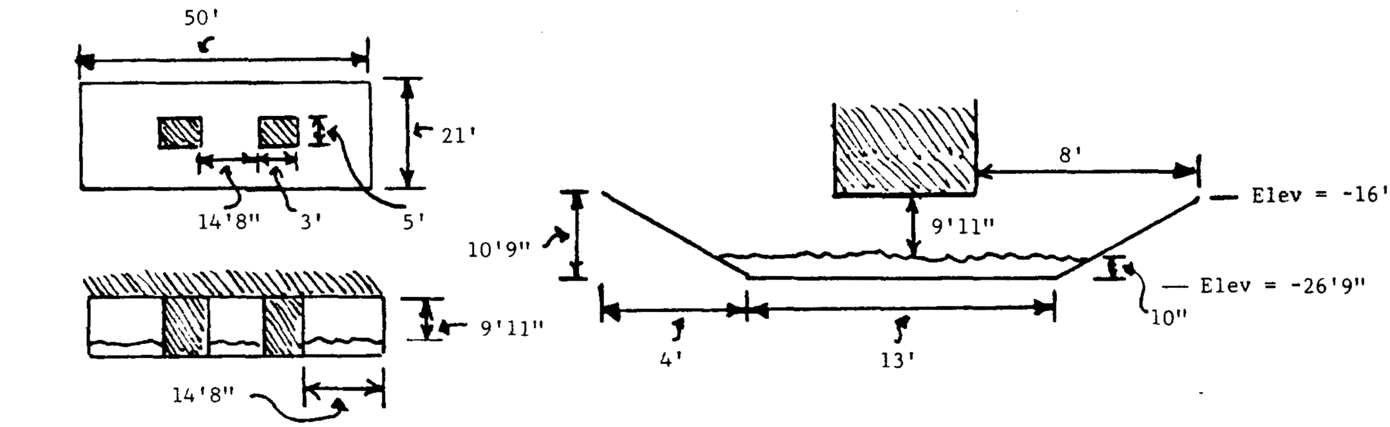
= 392.5 ft^2

(add to concrete area)

A_{dJ} SG→PG = 3 x 13.5' x 12.67' = 513 ft^2

(subtract from conc area)

6) <u>SG Cell Sump</u> (Conversation with D. L. Wegener 7/21/86).



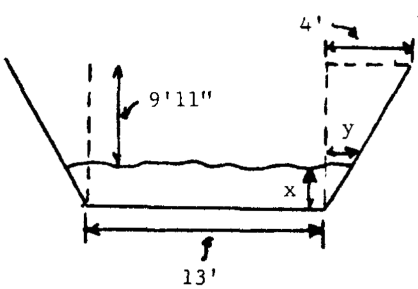
Junction Area = 3 x 14'8" x 9'11" = 436.33 ft^2

Sump Area = 50' x 21'-2 x 3' x 5' = 1,020 ft^2

Sump Volume = 13' x 9'11" x 14'8" x 3+4 x 4' x 9'11" x 3'

+2 x 1/2 x 4'x10'9" x 50' - 2 x 1/2

x 3.721" x 10" x 50' = 8,285.41 ft^3



x = 10"

$\frac{y}{x} = \frac{4'}{10'9''}$

$y = \frac{4' \times 10''}{10'9''} = 3.721''$

- Normally 10" of water when operating
- 300 gpm sump pump auto starts at 12" and dumps to Radioactive drain - stops at 10".
- One sump and one pump for each SG cell

Vol_S = 8,815-620 x dw-18.605 x dw^2

d_w in ft = depth of water

A_{JS} = 473-44 x dw

Vol_w = 620 x dw + 18.605 x dw^2

Assuming 10" normally:

We can approx. A_{JS} = 436.33-.05266 x vol added

Exact A_{JS} = 473-44x(10"/12+Δdw)

$$\text{Vol. added} = 620x(dw+\Delta dw)+18.605x(dw+\Delta dw)^2- 620xdw-18.605xdw^2$$

$$= 620x\Delta dw+18.605x(2xdwx\Delta dw+\Delta dw^2)$$

$$= 620x\Delta dw+18.605x(2x10''/12x\Delta dw+\Delta dw^2)$$

$$= 651x\Delta dw+18.605x\Delta dw^2$$

$$A_{JS} = 473-44x(10''/12+(-651\pm(651^2+4x18.605xvol_{added})^{1/2})2$$

$$x18.605) = 436.33-770x[1+1.76E-4x\ vol_{added}]^{1/2}$$

~ 436.33-.063x vol added. For small vol added.

Include 1/2 sump vol. in SG cell and 1/2 area subtract from conc.

Vol_S in SG = 4,142.71 ft^3 (add to vol.)

A_S = area = 510 ft^2 (subtract from area)

A_{JSG-PG} = 436.33 ft^2 (does not effect conc)

A_{SC} = area of ceiling = 1/2 x 3 x 14'8" x 5 '

= 110 ft^2(add to area)

$Elev_J$ = -20.96 ft.

7) Steel in SG Cell (NR_X NOTES)

Steel th(in)	Area (ft^2)
0.25	1,078
0.50	661
0.75	661
1.00	2,033
1.50	1,372
2.00	2,303
	8,108

Sam Woods notes = 8,457 ft^2

Surface areas of SGs

$$A = 2 \times 2 \times \pi \times R \times h + 2 \times \pi \times a^2 + \pi \times (b^2/\varepsilon)\ln((1+\varepsilon)/(1-\varepsilon))$$

ε = eccentricity = $(a^2-b^2)^{1/2}/a$ = .852

2a = major axis→a=5.25'

2b = minor axis→b=2.75'

$$A = 2 \times 2 \times \pi \times 5.25' \times 51.5' + 2 \times \pi \times 5.25'^2 + \pi \times (2.75'^2/.852) \times \ln((1+.852)/(1-.852))$$

$$= 3{,}397.63 + 173.18 + 70.44$$

$$= 3{,}641.25 \text{ ft}^2$$

This steel, since it was assumed hot, may not have been included in the above steel calculation.

We will assume Sam Woods' value of 8,457 ft^2 is correct and assume the extra 348 ft^2 is 0.25" thick.

From the NRx notes ρst = 8.03×10^3 kg/m^3 = 501 lbm/ft^3

$$Vol_{steel} = (0.25 \times 1{,}078+0.25 \times 348+0.5 \times 661+0.75 \times 661+1.0 \times 2{,}033 + 1.5 \times 1{,}372+2.0 \times 2{,}303) \times 1/12 = 823.3125 \text{ ft}^3$$

$$M_{steel} = 823.31 \text{ ft}^3 \times 501 \text{ lbm/ft}^3 = 412{,}479.56 \text{ lbm}$$

8) Summary of SG Cell

$$Vol = V_o - Vol_{2NPs} - Vol_{2SPs} - Vol_{2SG} + Vol_d + Vol_S$$

$$= 237{,}139.06-565.5-767.04-9{,}553.78 + 1{,}282.5 + 4{,}142.71$$

$$= 231{,}677.95 \text{ ft}^3$$

$$A_{conc} = A_o - A_{2NPs} - A_{2SPs} - A_{JSG \to PG} + A_d - A_S + A_{SC}$$

$$= 24{,}552.56 - 436 - 508.31 - 513 + 392.5 - 510 + 110$$

$$= 23{,}087.75 \text{ ft}^2$$

$$A_{steel} = 8{,}457 \text{ ft}^2$$

$$M_{steel} = 412{,}479.56 \text{ lbm} = 187{,}096.6 \text{ kg}$$

Compare:

	New	NRx Notes	Contempt
Vol	= 231,678 ft^3	218,743	218,743
$Area_{conc}$	= 23,088 ft^2	24,499	20,360
A_{steel}	= 8,457 ft^2	8,108	8,457
M_{steel}	= 412,480 lbm	408,847	412,480

The difference:

Vol: We included the sump volume, 1/2 duct volume (instead of all)and the length of the SG cell is 100' instead of 94'3". (There is an inconsistency in the notes.)

Area: We included 1/2 duct side walls, top of sump under wall and we removed the sump area and the top of the SG pedestals and subtracted 3.5' from wall height.

Other Stats:

Flame Propagation Length = 100'/2 = 50'

Characteristic Length = 50.67'

Sump Area = 510 ft^2

Sump Vol. = 8,285.41 ft^3

Top junction A_{JD} = 513 ft^2 $Elev_{CLduct}$ = 27.28 ft

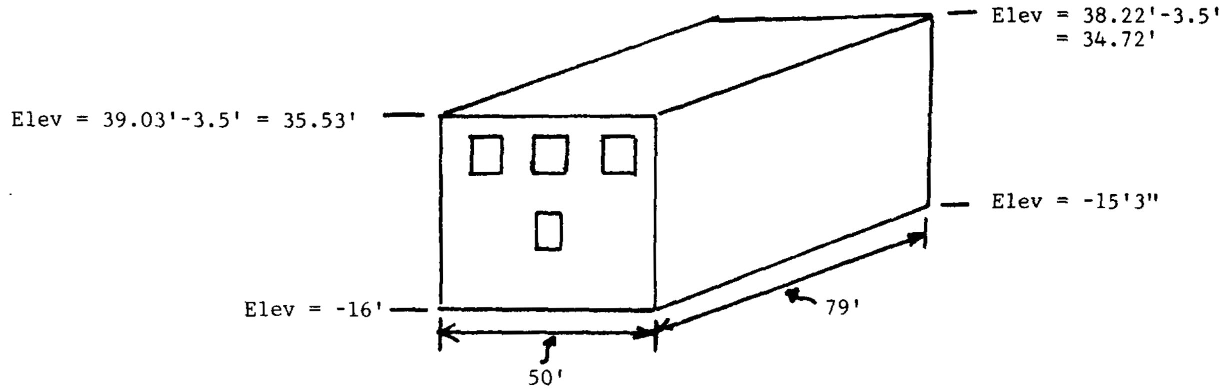
Bottom junction A_{JS} = 436.35 ft^2 $Elev_{CLsump}$ = 20.96 ft

Elev center cell = (61,914.06x(-7.8')+175,225x17.5')/237,139

= 10.9 ft (vol. average)

A.4 Calculation of Auxiliary Cell Characteristics

1) Basic calculation



Ave. elev. floor = -(16'+15'3")/2 = -15.625'

Ave. elev. roof = (35.53'+34.72')/2 = 35.125'

V_O = 79' x 50'x(35.125'+15.625') = 200,462.5 ft^3

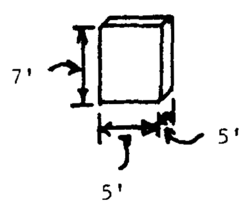
$A_F = A_C$ = 50' x 79' = 3,950 ft^2

A_W = 2x(50'+79')x(35.125'+15.625')=13,093.5 ft^2

$A_T = A_W + A_F + A_C$ = 20,993.5 ft^2

2) Door

1/2 door in aux. cell.

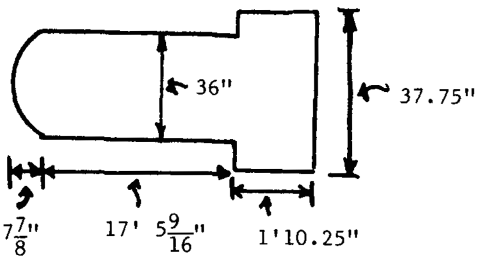


A_{Jdoor} = 5' x 7' = 35 ft^2 elev = 1/2x(35.53' + 16.0')-16' = 9.765 ft (assume door in center of cell face)

$A_W + A_C + A_F$ = 1/2 x 5'x2x(5'+7') = 60 ft^2

Vol_{door} = 1/2 x 7' x 5' x 5' = 87.5 ft^3

3) Graphite Coolers (4)



Vol_{GC} = 4x[2/3 x π x (7'-7/8") x (36"/2)^2+(17'5-9/16")

x π x (36"/2)+(1'10-1/4") x π x (37'-3/4"/2)^2]

= 563.79 ft^3

4) Steel (NR_x Notes)

Steel Thick(in)	Area (ft^2)
0.25	930
0.50	571
0.75	571
1.0	1,755
1.5	1,184
2.0	1,987
	6,998

Vol_{steel} = (0.25 x 930+0.5 x 571+0.75 x 571+1.0 x 1,755

+ 1.5 x 1,184+2.0 x 1,987)x1/12 = 704.27 ft^3

M_{steel} = 501 lbm/ft^3 x 704.27 ft^3 = 352,839.67 lbm

5) Ducts (same as SG cell)

Vol_d = 1,282.5 ft^3

A_{Jd} = 513 ft^2 elev. = 27.28 ft.

A_d = 392.5 ft^2

6) Summary of Aux. Cell

Vol = V_o + V_{door} + V_{ducts} - V_{gc}

= 200,462.5 ft^3+87.5 ft^3+1,282.5 ft^3-563.79 ft^3

= 201,268.71 ft^3

$A_{conc} = A_o + A_{door} - A_{Jdoor} + A_{ducts} - A_{Jducts}$

$= 20{,}993.5\ ft^2 + 60\ ft^2 - 35\ ft^2 + 392.5\ ft^2 - 513\ ft^2$

$= 20{,}898\ ft^2$

$A_{steel} = 6{,}998\ ft^3$

$M_{steel} = 352{,}839.67\ lbm$

Other stats:

Flame Propagation Length = 79/2 ft = 39.5 ft

Characteristic Length = 35.125 ft + 15.62 ft = 50.75 ft

Sump Area = 0

Sump Vol = 0

Top Junction: $A_{Jducts} = 513\ ft^2$ $Elev_{CLducts} = 27.28$ ft

Bottom Junction: $A_{Jdoor} = 35\ ft^2$ $Elev_{CLdoor} = 9.76$ ft

Elev CL_{cell} = (35.125 ft+15.625 ft)/2 - 15.625' = 9.75 ft

	New	NRx Notes	Contempt
Vol.	201,268.71 ft^3	201,061	201,060
Area conc	20,898 ft^2	21,143	17,168
Mrea steel	6,998 ft^2	6,998	6,998
Mass steel	352,839.67 lbm	352,839.67	352,839.67

Differences due to:

1) Error in notes in vol. calculation (16'+15'3")/2 = 15.625' not 15.875'.

2) For ducts included only 1/2 volume and area in volume.

3) Some amount of the steel covers the concrete, but we have no way of estimating this. As a result, all of our concrete areas are over-estimates. This will not affect the calculation since errors of the order of 20% have been shown previously not to affect the HECTR result.

A.5 Reactor Building Calculations

<u>Vol 18</u> - Graphite Gas Space in Core

Vol = 8,200 ft^3

$A_{graphite}$ = 10^6 ft^2

This is the interblock space which is thin and convoluted.

The height of the core is roughly ~37 ft

Flame Propagation Length = 37'/2 = 18.5 ft

Characteristic Length = 37 ft

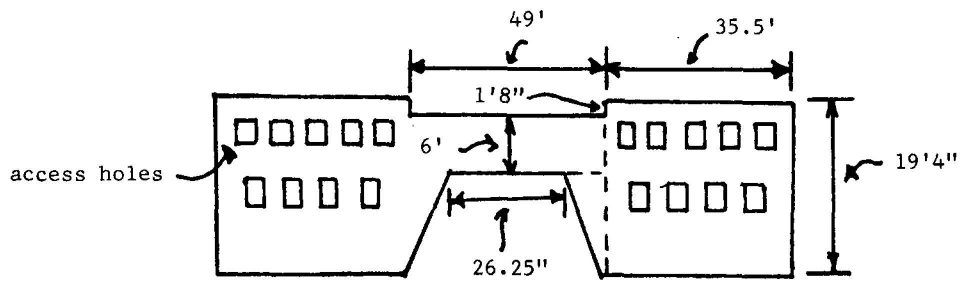
$Elev_{CL\ VOL}$ ~ 20 ft (centerline of Rx)

3 psid blowout panel to volume 17

$A_{J18 \rightarrow 17}$ = 7.10 ft^2 Elev ~ 7 ft

T = 700°F (assume remains at 700? Depends on accident scenario)

<u>Vols 16 & 17</u> - Front and Rear Pipe Barrier Space



Elev. vols 16 or 17 = 23.13 ft

Vol = 29'9"x(6'x24.5'+1/2x[19'4"-6'-1'8"]

x[24.5'-13'1.5"]+ 35.5'x19'4")x2

= 53,531 ft^3

A_{conc} = 29'9"x2 = 780.94 ft^2

A_{steel} = 29'9"x(13'1.5"+((24.5'-13'1.5")^2+

19'4"-6'-1.8")^2)$^{1/2}$+2x35.5'+19'4")x2

+4x(6'x24.5'+35.5x19'4"+1/2x[24.5'-13'1.5"]

x[19'4"-6-1'8"]

$= 7{,}125.3 + 3{,}598.75 = 10{,}724.05$ ft2

M_{steel} = 501 lbm/ft^3 x 223.4 ft^3 = 111,932.3 lbm
(assume 1/4" inside surface)

T ~ 400°F for vol. 16 and 450°F for vol. 17 initially

Flame Propagation Length = 35.5 + 24.5 = 60 ft

Characteristic Length = 30 ft

There are 18 access holes on top and 18 on bottom. They open up (i.e., gravity) under pressure. During operation, the lower holes are bolted shut from the inside.

$A_{J16\rightarrow 1}$ = 157.19 ft^2 Elev = 38 ft

$A_{J16\rightarrow 3}$ = 157.19 ft Elev = 38 ft

$A_{J17\rightarrow 7}$ = 157.19 ft^2 Elev = 38 ft

$A_{J17\rightarrow 9}$ = 157.19 ft Elev = 38 ft

$A_{J16\rightarrow 10}$ = 36 ft^2 Elev = 8.5 ft

$A_{J16\rightarrow 12}$ = 36 ft Elev = 8.5 ft

$A_{J17\rightarrow 13}$ = 36 ft^2 Elev = 8.5 ft

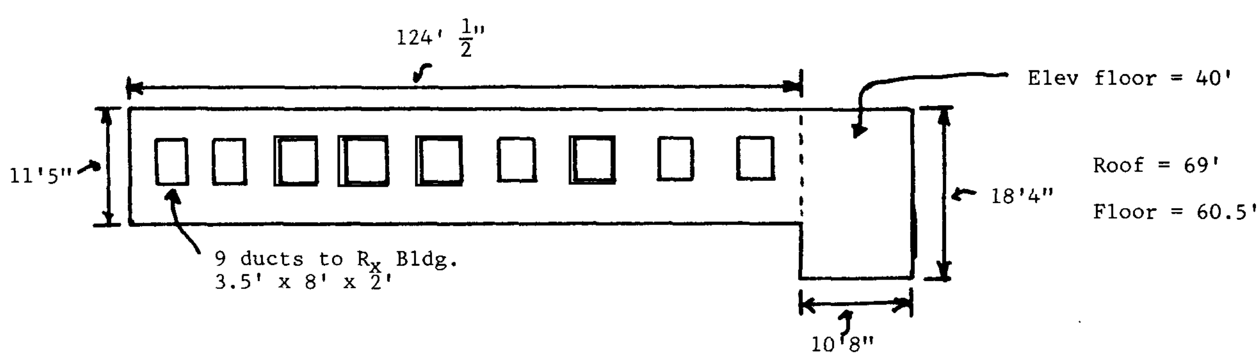
$A_{J17\rightarrow 15}$ = 36 ft Elev = 8.5 ft

(As per conversation, D. Wegener, 7/30/86, assumed lower holes are 2'x2' → area = 4 ft^2.)

Pressure to open top hatches ~536 lbm/(18.13 ft^2 x 144) = .21 psid

Pressure to open bottom hatches (if not bolted shut) ~104 lbm/(4 ft^2 x 144) = .18 psid

3) <u>Vol 38</u> - Room 605



$A_{J38\rightarrow4}$ = 84 ft^2 Elev = 59.5 ft

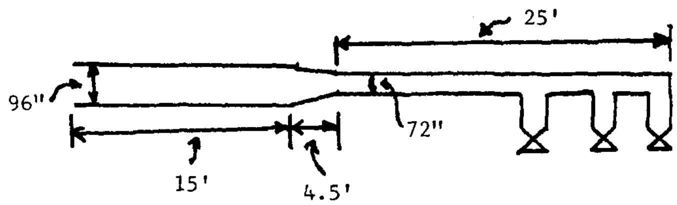
$A_{J38\rightarrow5}$ = 84 ft^2 Elev = 59.5 ft

$A_{J38\rightarrow6}$ = 84 ft^2 Elev = 59.5 ft

Vol = 11'5"x(69'-60.5')x(124'1/2")+10'8"x18'4"x(69'-40')

+1/2x9x3.5'x8'x2' = 17960.32 ft^3

Must add ductwork to isolation dampers



Vol_d = πx4'^{2}x15'+πx3'^{2}x25'+(4.5'/3)x[4'^{2}+4'x3'+ 3'^{2}]

= 1,516.34 ft^3

Vol 38 = 17,960.32+1,516.34 = 19,476.66 ft^3

A_{conc} = 2x11'5"x124'1/2" - 9x3.5'x8' + 2x8.5'x124' 1/2"

+ 11'5"x8.5'+2x10'8"x29'+2x10'8"x18'4"+18'4"x29'

+6.92'x29'-πx4'^{2}+11'5"x20.5' = 6,711.94 ft^2

A_{steel} = 2xπx3'x25'+2xπx4'x15'+π((4-3)^2+4.5^2)$^{1/2}$x(4+3)

= 899.8 ft^2

M_{steel} = 18.75 ft^3 x 501 lbm/ft^3 = 9391.67 lbm (Assume

1/4"):

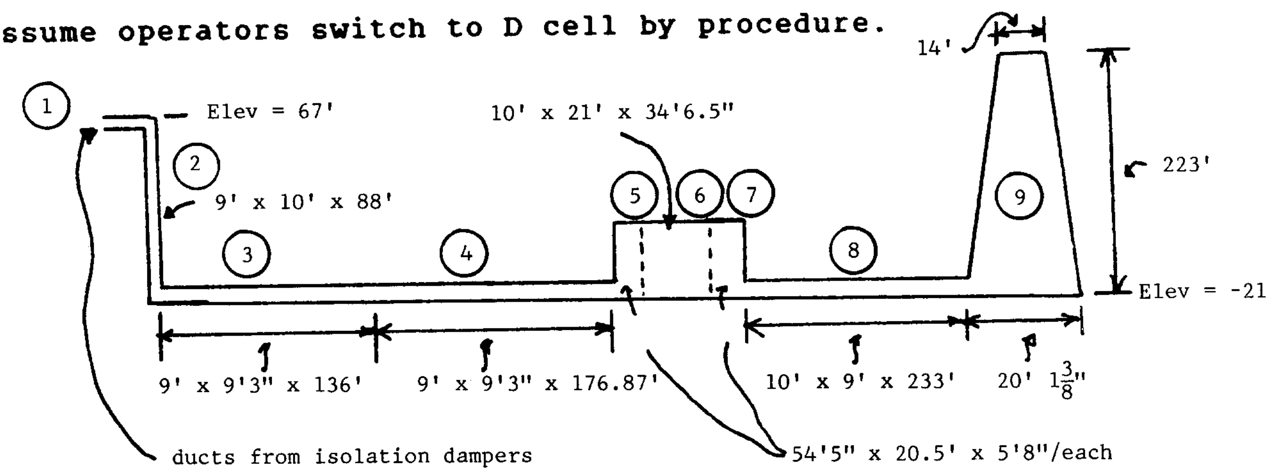
Elev Vol 38 = 64.75 ft

Flame Propagation Length = (124'1/2" + 10'8")/2 = 67.4 ft

Characteristic Length = 8.5 ft

4) __Filter Building__ - (Vol. 37 (Vol. 15))

Assume operators switch to D cell by procedure.



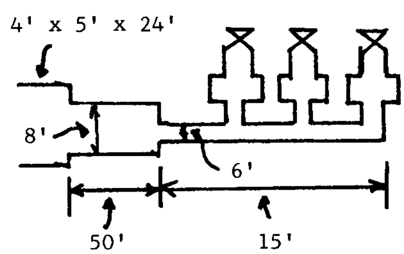
1, 2, 3, 4, 8 = steel

5, 6, 7, 9 = concrete

(1)→1 duct=3' rad, 15' length
   1 duct=4' rad, 50' length
   1 duct=4'x5' x 24'
   3 fans=4' rad, 4' length

$$A = 2\pi x3'x15'+2\pi x4'x50' + 3x2\pi x4'x4'+2x(4'+5')x24' = 2272.97 \text{ ft}^2 \text{ (not } 2675.1 \text{ ft}^2)$$

Area calculation in NR notes is incorrect (not consistent with volume calculation)



$Vol_{37} = 137,049 \text{ ft}^3$

$A_{conc} = 18,759 \text{ ft}^2$

$A_{steel} = 52,823 \text{ ft}^2$

$M_{steel} = 535,883.73$ lbm (assume .25" thick ducts)

Flame Propagation Length = (24'+88'+136'+176.87'+34.54' +11.33'+233'+223')/2 = 463.37 ft (assume burns from center)

Characteristic Length = 223 ft (assume dominated by stack)

$A_{J37 \to out}$ = 153.93 ft^2 Elev = 202 ft

$A_{J38 \to 37}$ = 75.78 ft^2 Elev = 64.75 ft

Elev Vol 37 = 27.4 ft weighted by volume (approx.)

$A_{J4 \to 38}$ = 84 ft^2 Elev = 58.5 ft

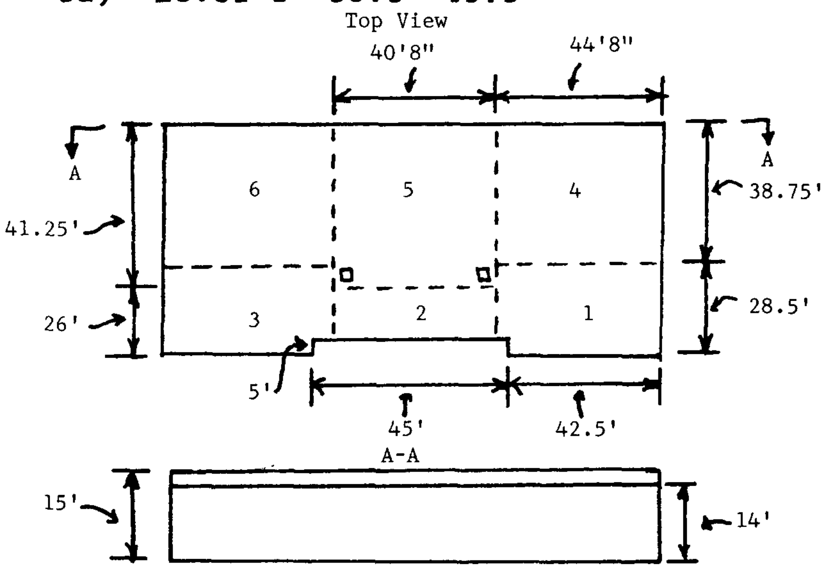
$A_{J5 \to 38}$ = 84 ft^2 Elev = 58.5 ft

$A_{J6 \to 38}$ = 84 ft^2 Elev = 58.5 ft

5) Reactor Building Front (Volumes 1, 2, 3, 4, 5, 6, 10, 11, and 12)

Because of the complexity of the calculation, we will go down one level at a time and calculate the partial volumes, areas, and elevations for all volumes at that level. At the end, we will add up the partial characteristics to get totals for each volume.

5a) Level 1 58.5'→43.5'



2' High, 4' Wide Opening to Rear of Reactor Building

<u>Volumes 1, 3</u>

$Vol_{1,3}$ = 15'x[44'8"x(28.5'-5')+5'x42.5'] = 18,932.5 ft^3

A_{conc} = 15' x (28.5'+44'8"+5') + 44'8"x(28.5'-5') + 5 x 42.5' = 2,434.67 ft^2

$A_{J2\to3} = A_{J1\to2} = (26'-5') \times 15' = 315\ ft^2$ Elev = 51 ft

$A_{J3\to6} = A_{J1\to4} = 44'\ 8" \times 15' = 670\ ft^2$ Elev = 51 ft

$Elev_{CL\ VOL} = 51\ ft$

Volumes 4,6

This includes three junctions to volume 38 (Room 605) on top of the reactor building which are 3.5'x8'x2' each.

$$Vol_{4,6} = 44'8" \times 38.75' \times 15'+1/2 \times 2'x4' \times 44'8"$$
$$+ 1/2 \times 3 \times 2' \times 3.5' \times 8' = 26{,}225.167\ ft^3$$

$$A_{conc} = 44'8" \times 38.75' + 15' \times (38.75'+44'8")-2' \times 44'8"$$
$$+ 2' \times 2' + 2' \times 44'8" \times 2-3 \times 3.5' \times 8'$$
$$+3 \times 1/2 \times (3.5'+8')x2 = 3{,}025.92\ ft^2$$

$A_{J4\to4} = A_{J6\to9} = 2'x44'8" = 89.33\ ft^2$ Elev = 57.5 ft

$A_{J4\to5} = A_{J5\to6} = 15' \times 38.75'+2'x2' = 585.25\ ft^2$

Elev = 51 ft

$A_{J4\to38} = A_{J6\to38} = 3 \times 3.5' \times 8' = 84\ ft^2$

Elev = 59.5 ft

$Elev_{CL\ VOL} = 51\ ft$

Volume 5

$$Vol_5 = 40'8" \times 41.25'x15'+1/2x2'x4'x40'8"+1/2x3x2'$$
$$x3.5'x8'-2 \times 3'8" \times 4'x8'3-1/2" = 25{,}165.944\ ft^3$$

$$A_{conc} = 2 \times 40'8" \times 41.25' + 15' \times 40'8" - 2' \times 40'8"$$
$$+ 2' \times 40'8" \times 2 - 3 \times 3.5' \times 8' + 3 \times 1/2 \times 2$$
$$\times (3.5'+8')+2x(3'8"+4')x8'3.5"x2 = 4{,}251.11\ ft^2$$

$A_{J5\to8} = 2'x40'8" = 81.33\ ft^2$ Elev = 57.5 ft

$A_{J2\to5} = 15'x40'8" = 610\ ft^2$ Elev = 51.5 ft

$A_{J5\to38} = 3x3.5'x8' = 84\ ft^2$ Elev = 59.5 ft

This includes three junctions to volume 38 on the roof similar to volumes 4,6 and two pillars which are 3'8"x4'x8'3.5" each.

$Elev_{CL\ VOL}$ = 51 ft.

<u>Volume 2</u>

Vol_2 = 15' x 40'8" x (26'-5') + 5,054.33 + 2' x 2' x 26.25'

= 17,969.33 ft^3

A_{conc} = (26'-5') x 40'8" -2' x 26.25' + 2 x (2'+26.25') x 2'

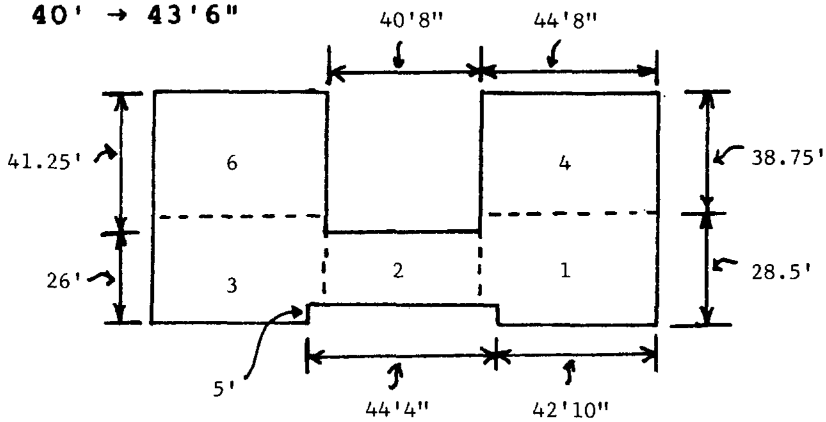
+ 2 x 2' x 2' + 40'8" x 15' + 2,123.94 = 3,648.44 ft^2

$A_{J2\rightarrow5}$ = 15' x 40'8" = 610 ft^2 Elev = 51 ft

$Elev_{CL\ VOL}$ = 51 ft

This includes the 605 Room on the roof with a 2' x 26.25' junction to the room from the main volume 2 into which the thermal shield fits when raised. The room is 42'10" x 14'9" x 8' high.

5b) Level 2 40' → 43'6"



<u>Volumes 1,3</u>

$Vol_{1,3}$ = 44'8" x (28.5' - 5') x 3.5' + 5' x 3.5' x 42'10"

= 4,423.42 ft^3

A_{conc} = 3.5' x (28.5' + 44'8" + 5') + 3.5' x 2.5'

= 282.33 ft^2

$A_{J3\rightarrow6}$ = $A_{J1\rightarrow4}$ = 3.5' x 44'8" = 156.33 ft^2 Elev = 41.75 ft

$A_{J2\rightarrow3}$ = $A_{J1\rightarrow2}$ = 3.5' x 21' = 73.5 ft^2 Elev = 41.75 ft

$Elev_{CL}$ VOL = 41.75 ft

Volumes 4,6

$Vol_{4,6}$ = 38.75' x 44'8" x 3.5' = 6,057.92 ft^3

A_{conc} = 38.75' x 44'8" + 3.5' x (38.75'x2+44'8")

= 2,158.42 ft^2

$Elev_{CL}$ VOL = 41.75 ft

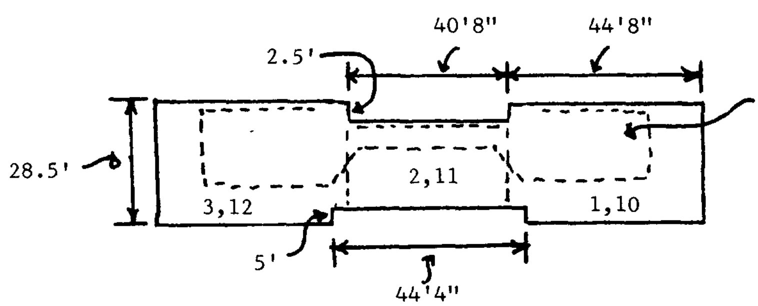
Volume 2

Vol_2 = 3.5' x 40'8" x (26'-5') = 2,989 ft^3

A_{conc} = 2 x 40'8" x 3.5' = 284.67 ft^2

$Elev_{CL}$ VOL = 41.75 ft

5c) Level 3 15' → 40'



Top of pipe barrier space is at ~38'

Volumes 1,2,3 extend down to 38' elevation

Volume 1,3

$Vol_{1,3}$ = (44'8" x 28.5' - 5' x 1' 10") x 2' = 2,527.67 ft^3

A_{conc} = (2 x 44'8" + 28.5' + 5') x 2' = 245.67 ft^2

$A_{J1\rightarrow2}$ = $A_{J2\rightarrow3}$ = (28.5' - 5'-2.5') x 2' = 42 ft^2

Elev = 39 ft

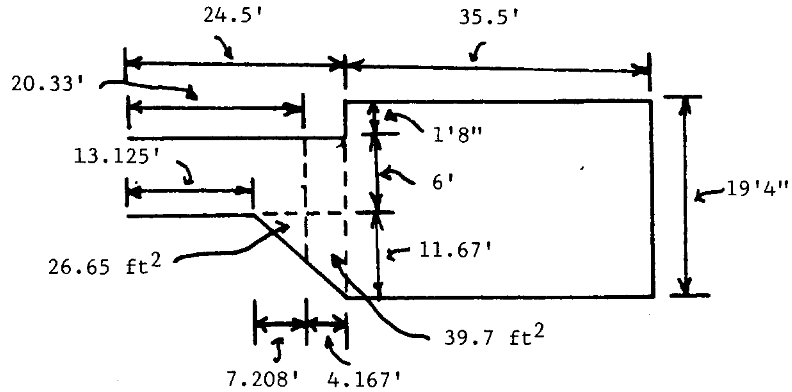
$A_{J1\rightarrow10}$ = $A_{J3\rightarrow12}$ = 44'8" x 28.5' - 5'x1'1'10"

- 35.5' x 19'4" - 4.167' x 6' - 39.70

= 512.80 ft^2 Elev = 38 ft

$Elev_{CL}$ VOL = 39 ft

The area of $J_{1\to10}$ has the surface of the pipe barrier subtracted from it.



<u>Volume 2</u>

Vol_2 = 40'8" x 2' x (28.5'-5'-2.5') = 1,708 ft^3

A_{conc} = 2 x 2' x 40' 8" = 162.67 ft^2

$A_{J2\to11}$ = 40'8" x (28.5'-5'-2.5')-2 x (6' x 20.33'

+ 26.65) = 556.74 ft^2 Elev = 38 ft

The area of J2→11 has the surface of the pipe barrier space subtracted from it.

$Elev_{CL\ VOL}$ = 39 ft

<u>Volumes 10,12</u>

$Vol_{PBS\ in\ 10}$ = (38'-15') x (35.5' x 19'4" + 39.70

+ 6' x 4.167') = 17,273.81 ft^3

$Vol_{10,12}$ = (44'8" x 28.5' - 5' x 1'10") x (38'-15')

- 17,273.81 = 11,694.35 ft^3

A_{conc} = (2 x 44'8" + 28' + 5'+ 1'10") x (38'-15')

= 2,855.83 ft^2

$A_{J10\to11}$ = $A_{J11\to12}$ = (38'-15') x (28.5'-5'-2.5'-6'-7.395')

= 174.92 ft^2 Elev = 26.5 ft

$Elev_{CL\ VOL}$ = 26.5 ft

<u>Volume 11</u>

$Vol_{PBS\ in\ 11}$ = (38'-15') x (6' x 40.67' + 2 x 26.65)

= 6,837.90 ft^3

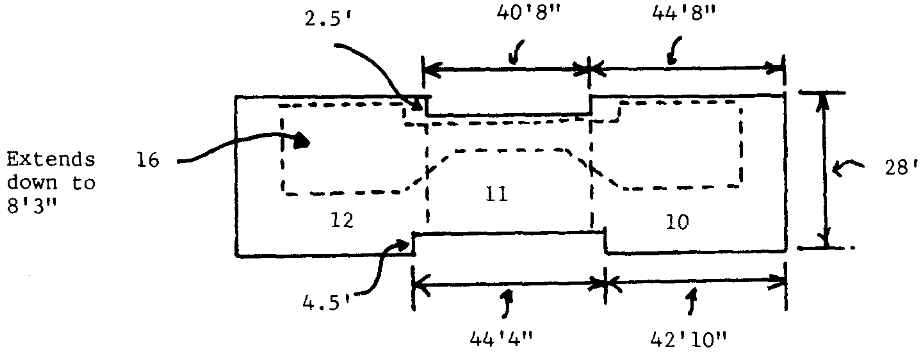
Vol_{11} = 40' 8" x (28.5'-2.5'-5') x (38'-15') -6,837.90

= 12,804.10 ft^3

A_{conc} = 40'8" x (38'-15') = 935.33 ft^2

$Elev_{CL\ VOL}$ = 26.5 ft

5d) Level 4 0'→15'



Volumes 10,12

$Vol_{10,12}$ = [44'8" x (28'-4.5') + 4.5' x 42'10")] x 15'

-6.75' x (35.5' x 19'4" + 39.70 + 6' x 4.167')

= 13,566.759 ft^3

A_{conc} = (2 x 44'8" + 28' + 4.5' + 2.5') x 15' = 1,865 ft^2

A_{J10-11} = $A_{J11\rightarrow12}$ = 6.75' x (28'-2.5'-4.5'-6'-7.395')

+ (15'-6.75') x (28'-2.5'-4.5') = 224.58 ft^2

Elev = 5.839 ft

$Elev_{CL\ VOL}$ = 5.81 ft

Volume 11

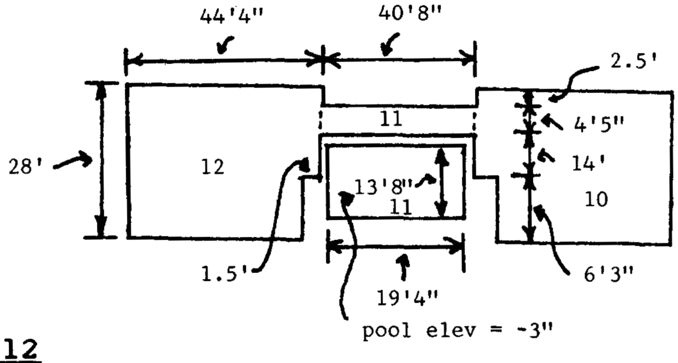
Vol_{11} = 40'8" x 15'x(28'-4.5'-2.5') -6.75' x (6'x40.67'

+ 2x26.65) = 10,808.63 ft^3

A_{conc} = 40'8" x 15' + 40'8" x 8'3" = 945.5 ft^2

$Elev_{CL\ VOL}$ = 6.47 ft

5e) Level 5 0'→ -15' 4"



Volumes 10,12

$Vol_{10,12}$ = [44'4" x 28'-6'3" x 1.5'] x 15'4" = 18,890.028 ft^3

A_{conc} = [2 x 44'4" + 2 x 28'-4'5"] x 15'4" = 2,150.5 ft^2

$A_{J10\rightarrow 11}$ = $A_{J11\rightarrow 12}$ = 4'5" x 15'4" = 67.72 ft^2 Elev = -7.67 ft

$Elev_{CL\ VOL}$ = -7.67 ft

Volume 11

Vol_{11} = 3" x 19'4" x 13'8" + 15'4" x 4'5" x 40'8"

= 2,820.09 ft^3

A_{conc} = (19'4" + 13'8") x 2 x 3" + 40'8" x 2 x 15'4"

+ 40'8" x (28'-2.5'-4.5') + 40'8" x (2' + .5')

-264.22 = 1,955.06 ft^2

$Elev_{CL\ VOL}$ = -7.67 ft

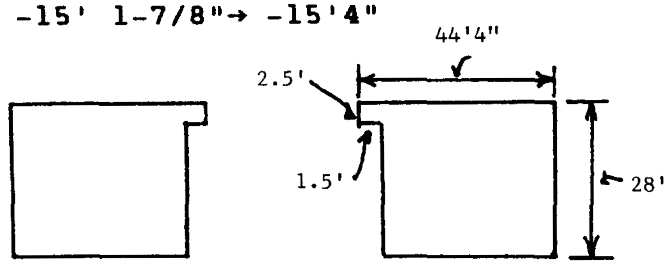
A_{Water} = 19'4" x 13'8" = 264.22 ft

$Elev_{CL\ VOL}$ = -7.67 ft

There is an inconsistency in the NRX Notes at this level. On page 5-23, the length of section 11 is reported as 38'4", not 40'8" which we use , but this is inconsistent with the pool being 19'4" and with the overall dimension of the reactor building.

Also, we add to volume 11, the area of the floor plus the lip on the reactor plus the reactor building face. We subtract the area of the water.

5f) Level 6 -15' 1-7/8"→ -15'4"



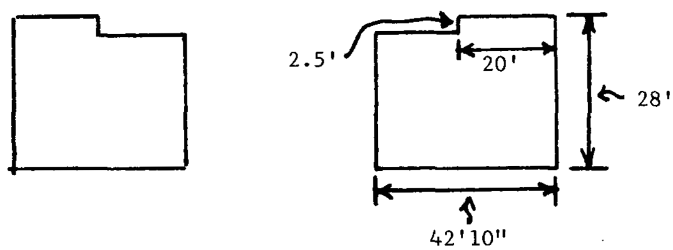
Volumes 10,12

$$Vol_{10,12} = (15'4"-15'\ 1\text{-}7/8") \times [28' \times (44'4"-1.5') + 1.5' \times 2.5'] = .0177 \times 1,203.08 = 213.046\ ft^3$$

$$A_{conc} = (2 \times 44'4" + 2 \times 28') \times .0177 = 25.62\ ft^2$$

$$Elev_{CL\ VOL} = -15.24\ ft$$

5g) Level 6 -15' 1-7/8"→-19.5'



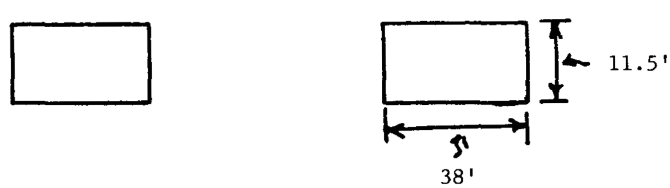
Volumes 10,12

$$Vol_{10,12} = (19.5'-15'\ 1\text{-}7/8") \times [42'10" \times 28'-(42'10"-20') \times 2.5'] = 4.34375' \times 1,142.25 = 4,961.65\ ft^3$$

$$A_{conc} = (2 \times 42'10" + 2 \times 28') \times (19.5'-15'\ 1\text{-}7/8") = 141.67 \times 4.34375' = 615.36\ ft^2$$

$$Elev_{CL\ VOL} = -17.328\ ft$$

5h) Level 7 -19.5'→ -21'2"



Volumes 10,12

$Vol_{10,12}$ = 11.5' x 38' x (21'2"-19.5') = 728.33 ft^3

A_{conc} = (11.5' + 38') x 2 x (21'2"-19.5') + 5' x 42.5'

+ 44'8" x (28.5'-5') = 1,427.17 ft^2

$Elev_{CL\ VOL}$ = -20.33 ft

At this level, we add all the floor which really exists at different levels, but is within volumes 10 or 12.

5i) Steel

M_{steel} = 734,883.5 A_{steel} = 17,192 ft^2

Because we do not know the exact distribution of steel, we will apportion the steel by volume ratio. The totals are from Reference 5.

Volume	Area (ft^2)	Mass (lbm)
1	1,534.71	65,602.02
2	1,336.41	57,125.73
3	1,534.71	65,602.02
4	1,902.35	81,317.21
5	1,490.73	63,722.19
6	1,902.35	81,317.21
10	2,975.45	127,187.61
11	1,539.85	65,821.97
12	2,975.45	127,187.61

5j) Summary of Volume Characteristics for Front of Reactor Building

Volume 1,3

Vol_1 = Vol_3 = 18,932.5 + 4,423.42 + 2,527.67

= 25,883.58 ft^3

A_{conc} = 2,434.67 + 282.33 + 245.67 = 2,962.67 ft^2

$A_{J1\rightarrow 2}$ = $A_{J2\rightarrow 3}$ = 315 + 73.5 + 42 = 430.5 ft^2

Elev = 48.25 ft

$A_{J1\rightarrow 4}$ = $A_{J3\rightarrow 6}$ = 670 + 156.33 = 826.33 ft^2

Elev = 49.25 ft

$A_{J1\rightarrow10} = A_{J3\rightarrow12} = 512.80\ ft^2$ Elev = 38 ft

$Elev_{CL}$ VOL = 48.24 ft

$A_{steel} = 1{,}534.71\ ft^2$

$M_{steel} = 65{,}602.02$ lbm

Flame Propagation Length = 44'8"/2 = 22.33 ft

Characteristic Length = 20.5 ft

Volume 2

$Vol_2 = 17{,}969.33 + 2{,}989 + 1{,}708 = 22{,}666.33\ ft^3$

$A_{conc} = 3{,}648.44 + 284.67 + 162.67 = 4{,}095.78\ ft^2$

$A_{J2\rightarrow5} = 610\ ft^2$ Elev = 51 ft

$A_{J2\rightarrow11} = 48.24\ ft^2$ Elev = 38 ft

$Elev_{CL}$ VOL = 48.24 ft (neglect room 605 in elev calculation)

$A_{steel} = 1{,}336.41\ ft^2$

$M_{steel} = 57{,}125.73$ lbm

Flame Propagation Length = 40'8"/2 = 20.33 ft

Characteristic Length = 20.5 ft

Volumes 4,6

$Vol_4 = Vol_6 = 26{,}225.17 + 6{,}057.92 = 32{,}283.09\ ft^3$

$A_{conc} = 3{,}025.92 + 2{,}158.42 = 5{,}184.34\ ft^2$

$A_{J4\rightarrow7} = A_{J6\rightarrow9} = 89.33\ ft^2$ Elev = 57.5 ft

$A_{J4\rightarrow5} = A_{J5\rightarrow6} = 585.25\ ft^2$ Elev = 51 ft

$A_{J4\rightarrow38} = A_{J6\rightarrow38} = 84\ ft^2$ Elev = 59.5 ft

$Elev_{CL}$ VOL = 49.26 ft

$A_{steel} = 1{,}902.35\ ft^2$

$M_{steel} = 81{,}317.21$ lbm

Flame Propagation Length = 44'8"/2 = 22.33 ft

Characteristic Length = 18.5 ft

Volume 5

Vol_5 = 25,165.94 ft^3

A_{conc} = 4,251.11 ft^2

$A_{J5\rightarrow8}$ = 81.33 ft^2 Elev 57.5 ft

$A_{J2\rightarrow5}$ = 610 ft^2 Elev 51 ft

$A_{J5\rightarrow38}$ = 84 ft^2 Elev 59.5 ft

$Elev_{CL\ VOL}$ = 51 ft

A_{steel} = 1,490.73 ft^2

M_{steel} = 63,722.19 lbm

Flame Propagation Length = 41'3"/2 = 20.63 ft

Characteristic Length = 15 ft

Volumes 10,12

$Vol_{10} = Vol_{12}$ = 1,194.35 + 13,566.76 + 18,890.03 + 213.05 + 4,961.65 + 728.33 = 51,163.92 ft^3

A_{conc} = 2,855.83 + 1,865 + 2,150.5 + 25.62 + 615.36 + 1,427.17 = 8,939.48 ft^2

$A_{J10\rightarrow11} = A_{J11\rightarrow12}$ = 174.92 + 224.58 + 67.72 = 467.22 Elev = 11.61 ft

$Elev_{CL\ VOL}$ = 2.66 ft

A_{steel} = 2,975.45 ft^2

M_{steel} = 127,187.61 lbm

Flame Propagation Length = 59'2"/2 = 29.58 ft

Characteristic Length = 59'2" = 59.17 ft

There are differences in the elevation of the volume and the junction area from those values in the model. These calculations represent a best estimate of the volume weighting due to the front pipe barrier space removing volume in the upper portion of volumes 10, 12, and 11 (see below) and the cross-sectioned area between volumes after removing the pipe barrier space.

Volume 11

Vol_{11} = 12,804.10 + 10,808.63 + 2,820.09

= 26,432.82 ft^3

A_{conc} = 935.33 + 945.5 + 1,955.06 = 2,075.89 ft^2

A_{water} = 264.22 ft^2

$Elev_{CL}$ VOL = 14.81 ft

A_{steel} = 1,539.85 ft^2

M_{steel} = 65,821.97 lbm

Flame Propagation Length = 53'4"/2 = 26.67 ft

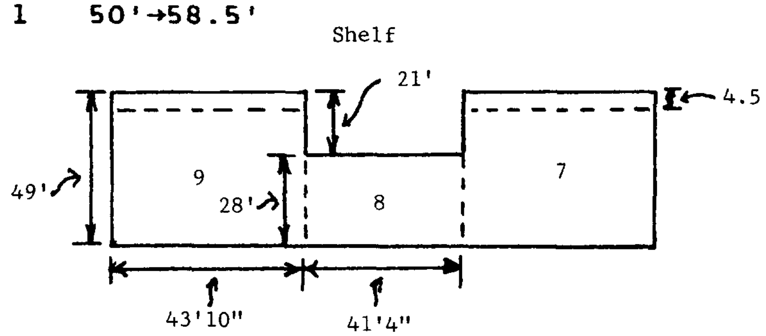
Characteristic Length = 53'4" = 53.33 ft

See note above in Volumes 10 and 12.

6) Reactor Building Rear (Volumes 7, 8, 9, 13, and 15)

Because of the complexity of the calculation, we will go down one level at a time and calculate the partial volumes, areas, and elevations for all volumes at each level. At the end, we will add up the partial characteristics to get totals for each volume.

6a) Level 1 50'→58.5'



Volumes 7,9

$Vol_{7,9}$ = 43'10" x 49' x 8.5' + 2' x 1/2 x 4' x 43' 10"

= 18,431.92 ft^3

A_{conc} = (2 x 43'10" + 49' + 21') x 8.5'-43'10" x 2'

+ 2 x 2'x 43'10"+2' x 2' + (49'-44.5') x 43'10"

$+ 49' \times 43'10" = 3,776.91\ ft^2$

$A_{J7\to8} = A_{J8\to9} = 28' \times 8.5' = 238\ ft\ Elev = 54.25\ ft$

$Elev_{CL\ VOL} = 54.25\ ft$

Volume 8

$Vol_8 = 41'4" \times 28' \times 8.5' + 1/2 \times 2' \times 4' \times 41'4" + 2'$

$\times 26.5' \times 2' + 4910.66 = 15,018.33\ ft^3$

$A_{conc} = 2 \times 41'4" \times 8.5' + 41'4" \times 28' + 2 \times 2' \times 41'4"$

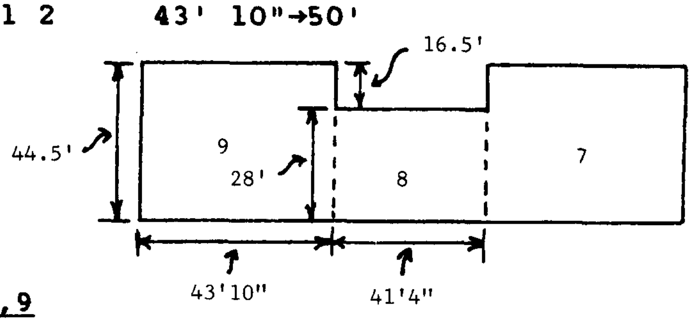
$- 2' \times 41'4" + 2,081 + 2 \times 2' \times 26.25' - 2' \times 26.25'$

$+ 2 \times 2' \times 2' = 4,084.17\ ft^2$

$Elev_{CL\ VOL} = 54.25\ ft$

Includes Room 604 on roof plus 2' x 26.25' junction to main part of Volume 8. Room 604 is 42'4" x 14'6" x 8' high.

6b) Level 2 43' 10"→50'



Volumes 7,9

$Vol_{7,9} = 43'10" \times 44.5' \times (50' - 43'10") = 12,028.60\ ft^3$

$Aconc = (44.5' + 16.5' + 2 \times 43'\ 10") \times (50' - 43'10")$

$= 916.78\ ft^2$

$A_{J7\to8} = A_{J8\to9} = 28' \times (50' - 43'10") = 172.67\ ft^2$

$Elev = 46.92\ ft$

$Elev_{CL\ VOL} = 46.92\ ft$

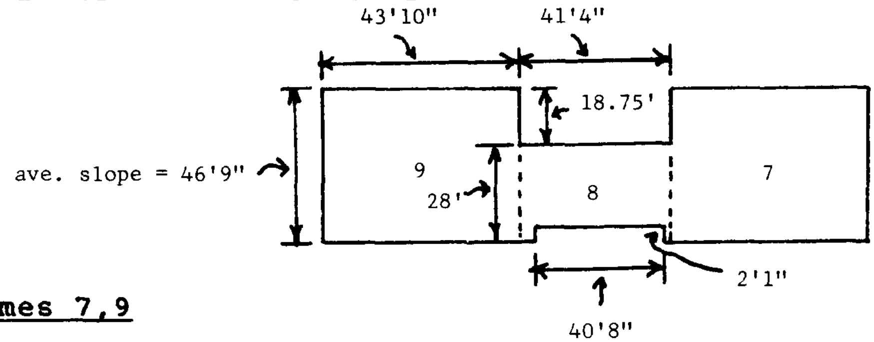
Volume 8

$Vol_8 = 28' \times (50' - 43'10") \times 41'4" = 7,136.89\ ft^3$

$A_{conc} = 2 \times 41'4" \times (50' - 43'10") = 509.78\ ft^3$

$Elev_{CL}$ VOL = 46.92 ft

6c) Level 3 38'8"→43'10"



<u>Volumes 7,9</u>

$Vol_{7,9}$ = 43'10" x 46'9" x (43'10"-38'8") = 10,587.576 ft^3

A_{conc} = (46'9" + 18.75' + 2 x 43'10") x (43'10"-38")

= 791.36 ft^2

$A_{J7\to8}$ = $A_{J8\to9}$ = 28' x (43'10"-38'8") = 144.67 ft^2

Elev = 41.25 ft

$Elev_{CL}$ VOL = 41.25 ft

<u>Volume 8</u>

Vol_8 = (41'4" x 28' - 40'8" x 2'1") x (43'10" - 38'8")

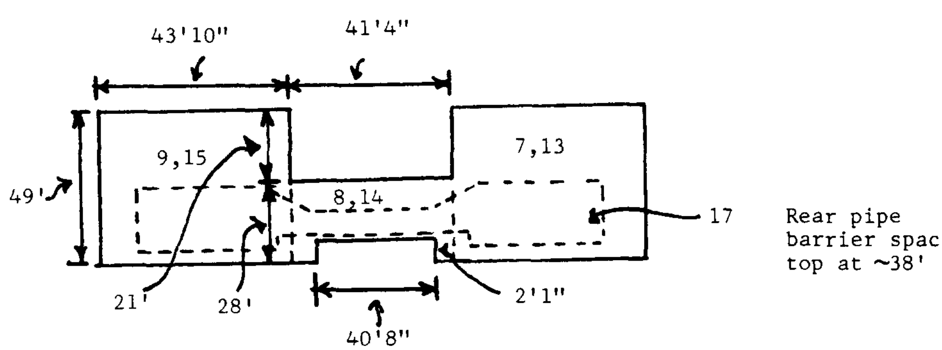
= 5,541.82 ft^3

A_{conc} = (2 x 41'4" + 2 x 2'1") x (43'10"-38") + 2'1"

x 40'8" = 533.36 ft^2

$Elev_{CL}$ VOL = 41.25 ft

6d) Level 4 22'→38'8"



Volumes 7,9

$Vol_{7,9}$ = 43'10" x 49' x 8" = 1,431.89 ft^3

A_{conc} = (2 x 43' 10" + 49' + 21') x 8" + 2 x (49'-46'9")

= 109.61 ft^2

$A_{J7\to8}$ = $A_{J8\to9}$ = 28' x 8" = 18.67 ft^2 Elev 38.33 ft

$A_{J7\to13}$ = $A_{J9\to15}$ = 49' x 43'10" -742.91 = 1,404.92 ft^2

Elev = 38 ft

$Elev_{CL\ VOL}$ = 38.33 ft

Volume 8

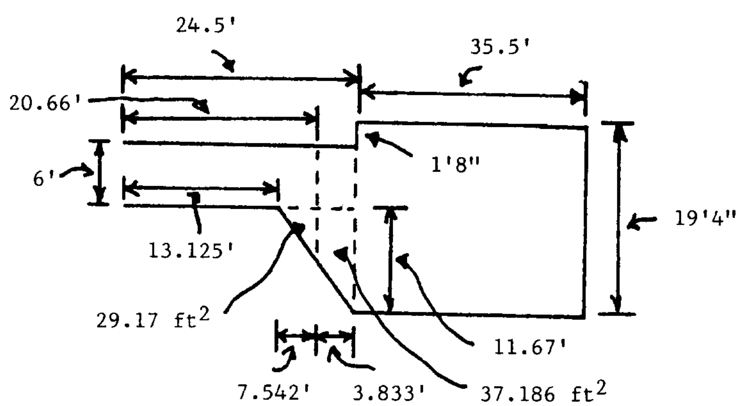
Vol_8 = (41'4" x 28'-2'1" x 40'8") x 8" = 715.07 ft^3

A_{conc} = (2 x 41'4" + 2 x 2'1") x 8" = 57.89 ft^2

$A_{J8\to14}$ = 41'4" x 28'-2'1" x 40'8"-2 x 153.13 = 766.35 ft^2

Elev = 38 ft

$Elev_{CL\ VOL}$ = 38.38 ft



Volumes 13,15

$Vol_{13,15}$ = 43'10" x 49' x (38'-22')-16' x 742.91

= 22,218.77 ft^3

A_{conc} = (2 x 43'10" + 49' + 21') x 16' = 2,522.67 ft^2

Elev = 30 ft

$A_{J13\to14} = A_{J14\to15} = 16' \times (28'-2'1"-6'-7.735')$

$= 194.91\ ft^2$ Elev = 30 ft

$Elev_{CL\ VOL} = 30\ ft$

<u>Volume 14</u>

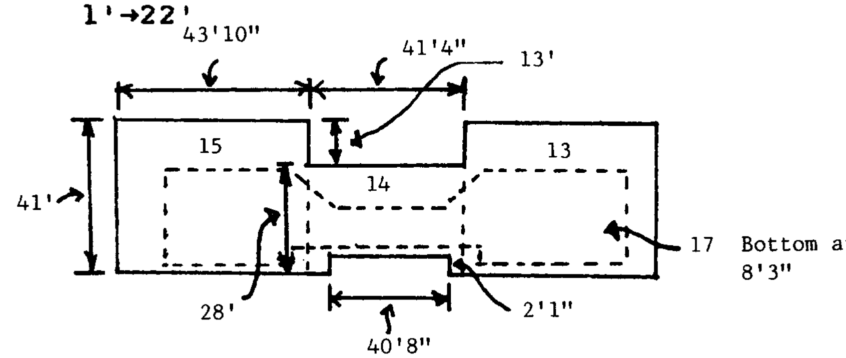
$Vol_{14} = (41'4" \times 28'-2'1" \times 40'8") \times 16'-16'x[2 \times 153.13]$

$= 12{,}261.62\ ft^3$

$A_{conc} = 41'4" \times 16' = 661.33\ ft^2$

$Elev_{CL\ VOL} = 30\ ft$

6e) Level 5 1'→22'



<u>Volumes 13,15</u>

$Vol_{13,15} = 43'10" \times 41' \times 21'-742.91 \times (22'-8'3")$

$= 27{,}525.49\ ft^3$

$A_{conc} = (2 \times 43'10" + 13' + 41') \times 21' + 8' \times 43'10" \times 2$

$= 3{,}676.34\ ft^2$

$A_{J13\to14} = A_{J14\to15} = 7'3" \times (28'-2'1") + 28'-2'1"-6"-7.735')$

$\times (22'-8'3") = 187.90 + 167.50 = 355.4\ ft^2$

Elev = 9.57 ft

$Elev_{CL\ VOL} = 10.15\ ft$

<u>Volume 14</u>

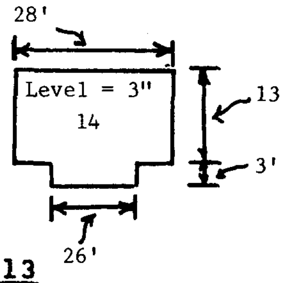
$Vol_{14} = (41'4" \times 28'-2'1" \times 40'8") \times 21'-(22'-8'3") \times 2$

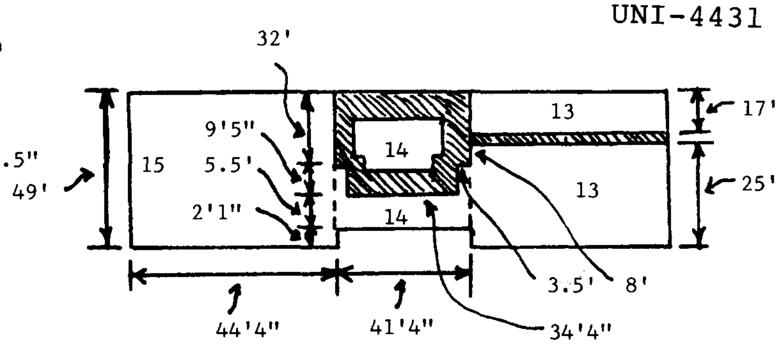
$\times 153.13 = 18{,}313.758\ ft^3$

$A_{conc} = 41'4" \times 21' + 41'4" \times 7'\ 3" = 1{,}167.67\ ft^2$

$Elev_{CL\ VOL} = 10.67\ ft$

6f) Level 6 $-1 \rightarrow 1'$





Volume 13

Vol_{13} = 17' x 44'4" x 2' + 25' x 44'4" x 2' = 3,724 ft^3

A_{conc} = (4 x 44'4" + 2 x 17' + 25' + 2'1" + 8') x 2'

= 492.83 ft^2

$A_{J13 \rightarrow 14}$ = 14' 11" x 2' = 29.83 ft^2 Elev = 0'

$Elev_{CL\ VOL}$ = 0'

Volume 14

Vol_{14} = 41'4" x 5.5' x 2' + 2 x 2' x 9'5" x 3.5' + 1'3" x

(28' x 13.5' + 26' x 3') = 586.5 + 570 = 1,156.5 ft^3

A_{conc} = 2 x (28' + 16.5') x 1'3" + 2' x (2 x 41'4"

+ 2 x 9'5")+ (28'-2'1") x 41'4" -456 = 930.47 ft^2

A_{water} = 13.5' x 28' + 3' x 26' = 456 ft^2

$Elev_{CL\ VOL}$ = 0.185 ft

At this level, we add the general floor area and subtract the area of the water.

Volume 15

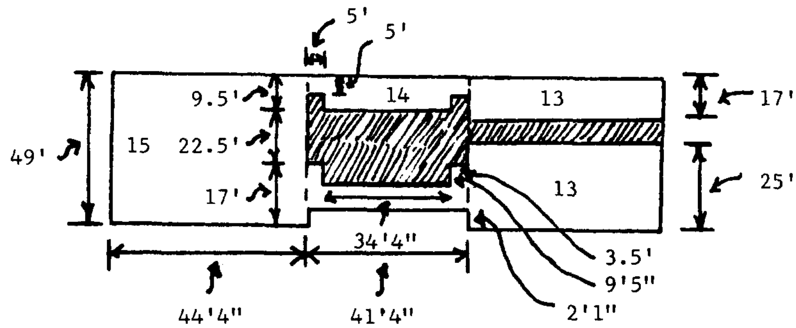
Vol_{15} = 44'4" x 49' x 2' = 4,344.67 ft^3

A_{conc} = (2 x 44'4" + 49' + 2'1" + 32') x 2' = 343.5 ft^2

$A_{J14 \rightarrow 15}$ = 29.83 ft^2 Elev = 0'

$Elev_{CL\ VOL}$ = 0'

6g) Level 7 -9'→-1'



Volume 13

Vol_{13} = (44'4" x 17' + 44'4" x 25') x 8' = 14,896 ft^3

A_{conc} = [4 x 44'4" + 2 x 17' + 2 x 25'-5'-(17'-2'1")]

x 8' = 1,931.33 ft^2

$Elev_{CL\ VOL}$ = -5 ft

$A_{J13\to14}$ = 5' x 8' + (17'-2'1") x 8' = 159.33 ft^2

Elev = -5 ft

Volume 14

Vol_{14} = [41'4" x 5.5' + 2 x 3.5' x 9'5" + 41'4" x 5'

+ (41'4"-10') x 4.5'] x 8' = 5,127.33 ft^3

A_{conc} = (4 x 41'4" + 2 x 4.5' + 2 x 9'5") x 8' + 5' x 41'4"

+ 4.5'x (41'4" -10') = 1,894.34 ft^2

$A_{J14\to15}$ = (5' + 17'-2'1") x 8' = 159.33 ft^2 Elev = -5 ft

$Elev_{CL\ VOL}$ = -5 ft

At this level, we add the rear ceiling.

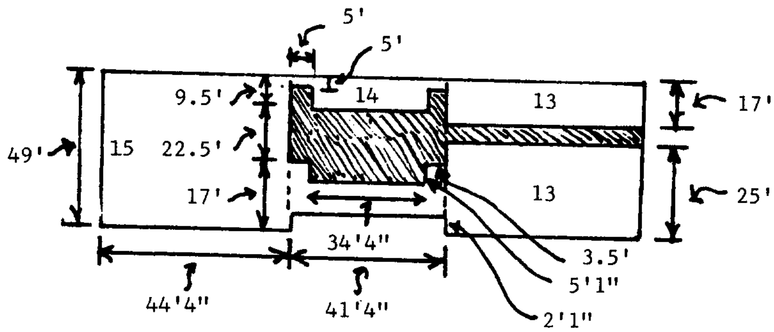
Volume 15

Vol_{15} = 49' x 44'4" x 8' = 17,378.67 ft^3

A_{conc} = [2 x (49' + 44'4")-5'-17' + 2'1"] x 8' = 1,334 ft^2

$Elev_{CL\ VOL}$ = -5 ft

6h) Level 8 -16'→-9'



<u>Volume 13</u>

Vol_{13} = (17' + 25') x 44'4" x 7' = 13,034 ft^3

A_{conc} = [4 x 44'4" + 2 x (17' + 25') -5'-(17'-2'1")]
x 7' = 1,689.92 ft^2

$A_{J13 \to 14}$ = 5' x 7' + (17'-2'1") x 7' = 139.42 ft^2

Elev = -12.5 ft

$Elev_{CL\ VOL}$ = -12.5 ft

<u>Volume 14</u>

Vol_{14} = (41'4" x 9'10" + 2 x 3.5' x 5'1" + 41'4" x 5'
(41'4" -10') x 4.5') x 7' = 5,527.86 ft^3

A_{conc} = (4 x 41'4" + 2 x 5'1" + 2 x 4.5') x 7'
= 1,291.5 ft^2

$A_{J14 \to 15}$ = 7' x 5' + 7' x (17'-2'1") = 139.42 ft^2

Elev = -12.5 ft

$Elev_{CL\ VOL}$ -12.5 ft

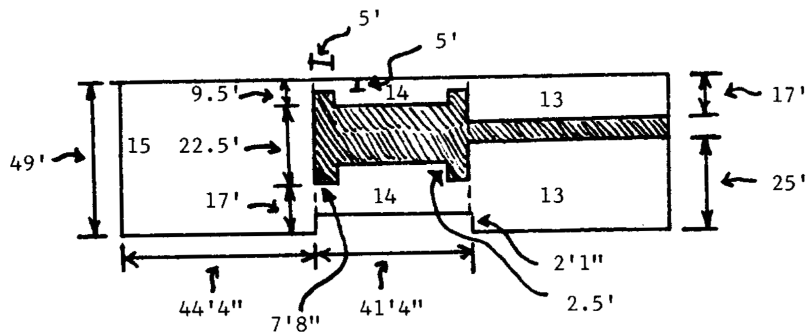
<u>Volume 15</u>

Vol_{15} = 49' x 44'4" x 7' = 15,206.33 ft^3

A_{conc} = [2 x (49' + 44'4") -5'-(17'-2'1")] x 7'
= 1,167.25 ft^2

$Elev_{CL\ VOL}$ = -12.5 ft

6i) Level 9 $-17' \rightarrow -16'$



Volume 13

Vol_{13} = 1' x 44'4" x (25' + 17') = 1,862 ft^3

A_{conc} = 1' x [4 x 44'4" + 2 x (17' + 25') -5'-(17'-2'1")]

+ 49'x 44'4" = 2,413.75 ft^2

$A_{J13 \rightarrow 14}$ = 1' x 5' + 1' x (17'-2'1") = 19.92 ft^2

Elev = -16.5 ft

$Elev_{CL\ VOL}$ = -16.5 ft

At this level, we add all the floor.

Volume 14

Vol_{14} = 1' x 5' x 41'4" + 1' x 4.5' x (41'4"-10')

+ 1'x (17'-2'1") x 41'4" + 1' x 2.5' x 26'

= 1,029.22 ft^3

A_{conc} = (4 x 41'4" + 2 x 4.5' + 2 x 2.5') x 1' + 5' x 41'4"

+ 4.5'x (41'4"-10') = 527.0 ft^2

$A_{J14 \rightarrow 15}$ = 1' x 5' + 1' x (17'-2'1") = 19.92 ft^2

Elev = -16.5 ft

$Elev_{CL\ VOL}$ = -16.5 ft

At this level, we add the rear floor.

Volume 15

Vol_{15} = 49' x 44'4" x 1' = 2,172.33 ft^3

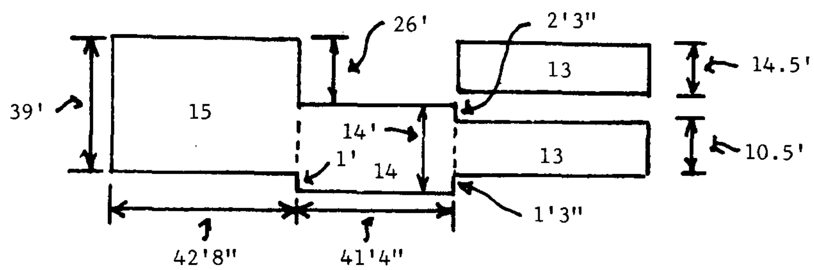
A_{conc} = [2 x (49' + 44'4")-5'-(17'-2'1")] x 1'

+ 49' x 44'4"= 2,339.08 ft^2

Elev CL vol = -16.5 ft

At this level, we add all the floor, even the portion at the 1' level.

6j) Level 10 -19.5'→-17'



Volume 13

Vol_{13} = 42'8" x (14.5' + 10.5') x 2.5' = 2,666.67 ft^3

A_{conc} = (4 x 42'8" + 2 x 14.5' + 10.5') x 2.5'

= 525.42 ft^2

$A_{J13\rightarrow14}$ = 2.5' x 10.5' = 26.25 ft^2 Elev = -18.25 ft

$Elev_{CL}$ VOL = -18.25 ft

Volume 14

Vol_{14} = 41'4"x14'x2.5' = 1,446.67 ft^3

A_{conc} = (2 x 41'4" + 1'3" + 2'3" + 1') x 2.5' + (14'-5.5')

x 41'4" -2 x 3.5' x 9'5" = 503.34 ft^2

$A_{J14\rightarrow15}$ = 2.5' x 13' = 32.5 ft^2 Elev = -18.25 ft

$Elev_{CL}$ VOL = -18.25 ft

At this level, we add the ceiling under the overhanging sump.

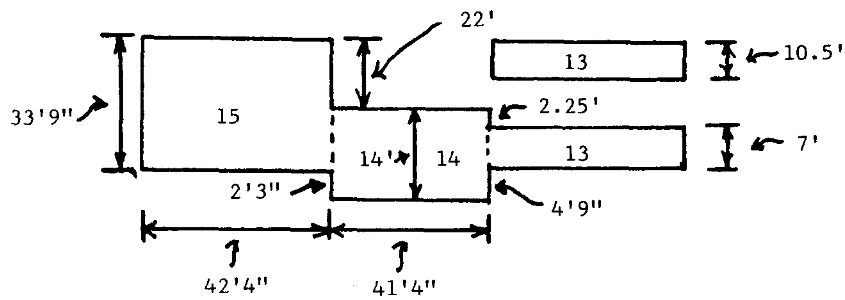
Volume 15

Vol_{15} = 39' x 42'8" x 2.5' = 4,160 ft^3

A_{conc} = (2 x 42'8" + 39' + 26') x 2.5' = 375.83 ft^2

$Elev_{CL}$ VOL = -18.25 ft

6k) Level 11 -21'2"→-19.5'



__Volume 13__

Vol_{13} = 42'4" x (10.5' + 7') x (21'2"-19.5')

= 1,234.72 ft^3

A_{conc} = [4 x 42'4" + 2 x (10.5' + 7')-7'] x (21'2" -19.5')

= 328.89 ft^2

$A_{J13\rightarrow14}$ = 7' x (21'2"-19.5') = 11.67 ft^2 Elev = -20.33 ft

$Elev_{CL}$ VOL = -20.33 ft

__Volume 14__

Vol_{14} = 41'4" x 14' x (21'2"-19.5') = 964.44 ft^3

A_{conc} = (2 x 41'4" + 4'9"+2'3" + 2.25') x (21'2"-19.5')

= 153.19 ft^2

$A_{J14\rightarrow15}$ = (33'9"-22') x (21'2" -19.5') = 19.58 ft^2

Elev = -20.33 ft

$Elev_{CL}$ VOL = -20.33 ft

__Volume 15__

Vol_{15} = 33'9" x 42'4" x (21'2"-19.5') = 2,381.25 ft^3

A_{conc} = (2 x 42'4" + 33'9" + 22') x (21'2"-19.5')

= 234.03 ft^2

$Elev_{CL}$ VOL = -20.33 ft

61) Steel

M_{steel} = 788,521.8 lbm A_{steel} = 15,651 ft^2

Because we do not know the exact distribution of steel, we will apportion the steel by volume ratio. The totals are from Reference 5.

Volume	Area (ft^2)	Mass (lbm)
7	1,944.35	97,959.33
8	1,295.48	65,268.24
9	1,944.35	97,959.33
13	3,996.45	201,347.62
14	2,097.45	105,672.96
15	4,372.94	220,315.75

6m) Summary of Volume Characteristics for Rear of Reactor Building

Volumes 7,9

$$Vol_7 = Vol_9 = 18{,}431.92 + 12{,}028.60 + 10{,}587.58$$

$$+ 1{,}431.89 = 42{,}485.40 \ ft^3$$

$$A_{conc} = 3{,}776.91 + 916.78 + 791.36 + 109.61$$

$$= 5{,}594.66 \ ft^2$$

$A_{J7\rightarrow13} = A_{J9\rightarrow15}$ = 1,404.92 ft^2 Elev = 38 ft

$$A_{J7\rightarrow8} = A_{J8\rightarrow9} = 238 + 172.67 + 144.67 + 18.67$$

$= 574.01 \ ft^2$ Elev = 48.25 ft

$Elev_{CL\ VOL}$ = 48.39 ft

A_{steel} = 1,944.35 ft^2

M_{steel} = 97,959.33 lbm

Flame Propagation Length = 49'/2 = 24.5 ft

Characteristic Length = 20.5 ft

Volume 8

$$Vol_8 = 15{,}018.33 + 7{,}136.89 + 5{,}541.82 + 715.07$$

$$= 28{,}412.11 \ ft^3$$

$$A_{conc} = 4{,}084.17 + 509.78 + 533.36 + 57.89 = 5{,}185.2 \ ft^2$$

$A_{J8 \to 14}$ = 766.35 ft^2 Elev = 38 ft

$Elev_{CL\ VOL}$ = 48.47 ft (neglect room 604 in elevation calculation)

A_{steel} = 1,295.48 ft^2

M_{steel} = 65,268.24 lbm

Flame Propagation Length = 41'4"/2 = 20.67 ft

Characteristic Length = 20.5 ft

Volume 13

Vol_{13} = 22,218.77 + 27,525.49 + 3,724 + 14,896 + 13,034 + 1,862 + 2,666.67 + 1,234.72 = 87,161.65 ft^3

A_{conc} = 2,522.67 + 3,676.34 + 492.83 + 1,931.33 + 1,689.92 + 2,413.75 + 525.42 + 328.89 = 13,581.06 ft^2

$A_{J13 \to 14}$ = 194.91 + 355.40 + 29.83 + 159.33 + 139.42 + 19.92 + 26.25 + 11.67 = 936.73 ft^2

Elev = -10.70 ft

Elev CL vol = 6.93 ft

A_{steel} = 3,996.45 ft^2

M_{steel} = 201,347.62 lbm

Flame Propagation Length = 59'2"/2 = 29.58 ft

Characteristic Length = 59'2" = 59.17 ft

See note on Volume 14.

Volume 14

Vol_{14} = 12,261.62 + 18,313.76 + 1,156.5 + 5,127.33 + 5,527.86 + 1,029.22 + 1,446.67 + 964.44 = 45,827.40 ft^3

A_{conc} = 661.33 + 1,167.67 + 930.47 + 1,894.34 + 1,291.5 + 527.0 + 503.34 + 153.19 = 7,128.83 ft^2

$A_{J14\rightarrow15}$ = 194.91 + 355.40 + 29.83 + 159.33 + 139.42

+ 19.92 + 32.5 + 19.58 = 950.0 ft^2 Elev = -10.83 ft

A_{water} = 456 ft^2

$Elev_{CL\ VOL}$ = 8.85 ft

A_{steel} = 2,097.45 ft^2

M_{steel} = 105,672.96 lbm

Flame Propagation Length = 59'2"/2 = 29.58 ft

Characteristic Length = 59'2" = 59.17 ft

The concrete area is less than in the model due to the area of the water not being subtracted originally.

The elevation of the volume is less than in the model due to the weighting of the upper part being reduced due to subtracting out the rear pipe barrier space. In the original model, the volume was subtracted, but the correct weighting was not calculated (see also volume 15 below and volume 13 above).

<u>Volume 15</u>

Vol_{15} = 22,218.77 + 27,525.49 + 4,344.67 + 17,378.67

+ 15,206.33 + 2,172.33 + 4,160 + 2,381.25

= 95,387.51 ft^3

A_{conc} = 2,522.67 + 3,676.34 + 343.5 + 1,334 + 1,167.25

+ 2,339.08 + 375.83 + 234.03 = 11,992.65 ft^2

$Elev_{CL\ VOL}$ = 5.33 ft

A_{steel} = 4,373.94 ft2

M_{steel} = 220,315.75 lbm

Flame Propagation Length = 59'2"/2 = 29.58 ft

Characteristic Length = 59'2" = 59.17 ft

See note on volume 14.

APPENDIX B

INPUT LISTING FOR BASE CASE

```
! INITIAL NAMELIST TYPE INPUT
UOA = 9
CMPUTR = CRAY
$ END OF NAMELIST INPUT
!*******************************************
! PROBLEM GEOMETRY AND CONTAINMENT DESCRIPTION
!*******************************************
N REACTOR BASE CASE 15 VOL$

THIS IS A 15 VOLUME DECK USED FOR SCOOPING CALCULATIONS OF
COMBUSTION RESPONSE AT N REACTOR

ALL SI UNITS




15 ! NUMBER OF COMPARTMENTS
!
! FOR EACH COMPARTMENT: AN ID, THE VOLUME (M**3), ELEVATION (M), FLAME
! PROPAGATION LENGTH (M), NUMBER OF SURFACES, AND INTEGERS
! SPECIFYING WHICH SUMP TO DUMP EXCESS WATER (FROM SUPERSATURATION)
! INTO AND WHICH SUMP THE SPRAYS FALL INTO.
!
C1-FRONTRXBLD
11243.    9.9  19.8  4 1 1
C2-REARRXBLD
11543.    5.7  19.8  4 2 2
C3-PIPE-GALL
2749.2   3.01  7.89  3 3 3
C4-PIPE-GALL
1761.2  -2.67  16.0  3 3 3
C5-PIPE-GALL
862.34  -2.67  9.14  2 3 3
C6-PIPE-GALL
2651.55 -2.67 24.38  3 3 3
C7-PIPE-GALL
1920.1   2.38  16.0  2 3 3
C8-PIPE-GALL
1096.3   2.38  9.14  2 3 3
C9-PIPE-GALL
2922.94  2.38 24.38  2 3 3
C10-PIPE-GALL
2090.85  8.06  16.0  2 3 3
C11-PIPE-GALL
1144.58  8.06  9.14  2 3 3
C12-PIPE-GALL
3118.53  8.06 24.38  2 3 3
C13-PRES-PENT
1189.15 18.21  7.32  1 3 3
C14-6SG-AUXCELLS
45067.   3.32 15.24  3 3 3
```

```
C15-FILTERBLD
3881.    8.35 141.3  2 0 0
!
! FOR EACH SUMP: SUMP NUMBER, MAXIMUM VOLUME (M**3), SUMP NUMBER THAT
! THIS SUMP OVERFLOWS TO
!
! SUMP 1 IS UNDERNEATH THE ELEVATOR IN FRONT RX BLDG. WHEN IT FILLS
! WATER FLOWS ONTO THE FLOOR AND INTO DRAINS. IT IS REMOVED FROM THE RX
! BLDG.
1 16.9  0
! SUMP 2 IS THE BANANA WALL. IT HAS A VERY LARGE VOLUME SINCE IT
! CONNECTS TO THE FUEL POOL;HOWEVER WE NEGLECT THAT HERE AND CALCULATE
! THE VOLUME IN THE CAVITY ONLY. SINCE WHEN IT OVERFLOWS THE WATER GOES
! TO THE DRAINS AND IS REMOVED FROM THE RX BLDG, THE EFFECT IS THE SAME
! AS IF WE INCREASED THE VOLUME BUT DID NOT ADD IT TO THE ROOM VOLUME.
2 413.  0
! THERE ARE 6 SUMPS WHICH WE TREAT AS 1. THIS VOLUME IS LARGER THAN
! THE REAL VOL=1497 SINCE WE WANT THE CODE TO CONTINUE TO SUBTRACT THE
! VOLUME OF WATER FROM THE PG AND SG VOLUMES.
3 3000. 0
$
!
! FOR EACH SURFACE: TYPE OF SURFACE, MASS OF SURFACE (KG), AREA OF
! SURFACE (M**2), CHARACTERISTIC LENGTH (M), SPECIFIC HEAT (J/KG/K),
! EMISSIVITY, INTEGER INDICATING WHICH SUMP THE CONDENSATE GOES INTO.
! FOR SLABS (STYPE = 1), THE NUMBER OF LAYERS IN THE SURFACE, AND FOR
! EACH, THE THICKNESS (M), THERMAL DIFFUSIVITY (M**2/S), AND THERMAL
! CONDUCTIVITY (W/M/K).  FINALLY, THE NODING INFORMATION AND BOUNDARY
! CONDITIONS ARE SPECIFIED (0'S INDICATE HECTR WILL DETERMINE
! THE VALUES INTERNALLY). NOTE THAT SOME OF THE NUMBERS SET TO 1.
! ARE NOT USED FOR THAT SURFACE TYPE.
!
! C1 SURFACES
!
SUMP1
3 15000. 24.55  4.16  1. .94 1
CONC1
1 1. 4143.3 24.3  1. .9  1
1
.3 1.6E-6 2.39
0 0. 0. 0.
CONC1H
1 1. 139.8  9.1   1. .9  1
1
.3 1.6E-6 2.39
0 0. -1. 477.
STEEL1
2 333336. 1597. 1. 531.7 .7 1
!
! C2 SURFACES
!
SUMP2
3 400800. 42.6 5.03 1. .94 2
```

```
CONC2
1 1. 4438.6 24.3 1. .9 2
1
.3 1.6E-6 2.39
0 0. 0. 0.
CONC2H
1 1. 139.8 9.1 1. .9 2
1
.3 1.6E-6 2.39
0 0. -1. 505.
STEEL2
2 357665.6 1454. 1. 531.7 .7 2
!
! C3 SURFACES
!
SUMP3
3 7515. 47.38 1.83 1. .94 3
CONC3
1 1. 1151. 15.78 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL3
2 76819.5 312. 1. 531.7 .7 3
!
! C4 SURFACES
!
SUMP4
3 15030. 94.77 1.83 1. .94 3
CONC4
1 1. 591.6 4.42 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL4
2 137122.8 556.98 1. 531.7 .7 3
!
! C5 SURFACES
!
CONC5
1 1. 356.74 4.42 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL5
2 78355.9 318.27 1. 531.7 .7 3
!
! C6 SURFACES
!
SUMP6
3 22545. 142.15 1.83 1. .94 3
CONC6
1 1. 886.96 4.42 1. .9 3
```

```
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL6
2 208949. 848.73 1. 531.7 .7 3
!
! C7 SURFACES
!
CONC7
1 1. 526.22 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL7
2 8066. 32.76 1. 531.7 .7 3
!
! C8 SURFACES
!
CONC8
1 1. 276.43 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL8
2 4609.2 18.72 1. 531.7 .7 3
!
! C9 SURFACES
!
CONC9
1 1. 763.9 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL9
2 12291. 49.93 1. 531.7 .7 3
!
! C10 SURFACES
!
CONC10
1 1. 896.75 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL10
2 16132.1 65.53 1. 531.7 .7 3
!
! C11 SURFACES
!
CONC11
1 1. 307.1 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
```

```
STEEL11
2 9218.3 37.44 1. 531.7 .7 3
!
! C12 SURFACES
!
CONC12
1 1. 1261.63 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL12
2 24582.2 99.85 1. 531.7 .7 3
!
! C13 SURFACES
!
CONC13
1 1. 543.8 14.6 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
!
! C14 SURFACES
!
SUMP14
3 45090. 284.3 1.83 1. .94 3
CONC14
1 1. 14810.7 15.4 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL14
2 1282600. 5364.1 1. 531.7 .7 3
!
! C15 SURFACES
!
CONC15
1 1. 1742.7 68. 1. .94 0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL15
2 243071.5 4907.3 1. 531.7 .7 0
!
!
! CONTAINMENT LEAKAGE INFORMATION
!
! NUMBER OF LEAKS, NUMBER OF PRESSURE AND TEMPERATURE-DEPENDENT
! LEAKAGE CURVES
!
! NOL  NOP  NOT
  13    1    0
! LEAK COMPARTMENT, TEMPERATURE-DEPENDENT LEAKAGE CURVE, PRESSURE-
! DEPENDENT LEAKAGE CURVE, CONTAINMENT FAILURE FLAG, CONTAINMENT
```

```
! FAILURE CRITERION, CONTAINMENT FAILURE AREA (M**2), LEAK ELEVATION
! (M), LEAK LOSS COEFFICIENT, L/A FOR LEAK (1/M)
!
! COMP  T CURVE  P CURVE  NCF    CRIT  AREA  ZJI  FLI    LA
! FILTERED RELEASE TO OUTSIDE.
  15     0        0       1       0.   14.3  61.6  1.0   .01
! LEAKS FROM SG CELLS.
  14     0        0       1       0.   .187  -4.9  17.14 .01
  14     0        0       1       0.   .005  10.7  1.0   .01
! VACUUM BREAKER FOR RX BLDG.
   1     0       -1       0   -1723.   1.3   17.8  1,6   .01
! VENT OPENS AT -1723 DIFF PRESS FULL OPEN AT -3446
! REGULAR STEAM VENT IN RX BLDG C1.
   1     0        0       5  115111.   2.63  17.8  1.74  .01
! VENT CLOSES AFTER 2 IN WG PRESSURE + 150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      23     19    4      1      6      1
! LEAK FROM PG TO OUTSIDE.
   6     0        0       1       0.   .003  -4.9  1.0   .01
! REGULAR STEAM VENTS IN PG C3(2).
   3     0        0       5  115111. 5.26   10.9  3.01  .01
! VENT CLOSES AFTER 2 IN WG PRESSURE + 150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      24     19    4      1      6      1
! REGULAR STEAM VENTS IN PG C10(4).
  10     0        0       5  115111. 10.52  10.9  3.01  .01
! VENT CLOSES AFTER 2 IN WG PRESSURE + 150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      25     19    4      1      6      1
! REGULAR STEAM VENTS IN PG C12(7).
  12     0        0       5  115111. 18.41  10.9  3.01  .01
! VENT CLOSES AFTER 2 IN WG PRESSURE + 150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      26     19    4      1      6      1
! VACUUM BREAKER IN PG.
  10     0       -1       0   -1723.    1.3  10.9  1.6   .01
! LEAK FROM REAR RX BLDG.
   2     0        0       1       0.   .003  12.2  1.0   .01
! LEAK FROM FRONT RX BLDG.
   1     0        0       1       0.   .003  12.2  1.0   .01
! SPECIAL STEAM VENT IN RX BLDG.
   1     0        0       5  109941.   2.63  17.8  1.74  .01
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      15     13    4      1      5      1
!
1    1
0.  10.   100.   1000.   1723.   2153.75    2584.5    3015.25    3446.  3
1.0E-8  1.0E-8 1.0E-8 1.0E-8 1.0E-8  .325      .65        .975     1.3
```

```
0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
!
! FLOW JUNCTION DATA: COMPARTMENT ID'S, TYPE OF CONNECTION, FLOW
! AREA (M**2), LOSS COEFFICIENT, L/A RATIO (1/M), RELATIVE POSITION OF
! COMPARTMENTS, AND JUNCTION ELEVATION (M).
! ADDITIONAL INFORMATION IS PROVIDED FOR JUNCTION TYPE 7.
!
! FROM FRONT TO REAR RX BLDG.
1    2    1  24.2  1.395  .01   0    17.53
! TO FILTER BLDG FROM RX BLDG (FILTER VENTS).
1    15    7  7.04 66.26  .01   0    19.74
!  OPEN TRIP  CLOSE TRIP  BLOWN TRIP  ABLOWN
       1           2           3        0.
!  OPEN TABLE  TYPE TABLE  CLOSE TABLE TYPE TABLE
       1           1           2        1
! DUCTS FROM PG TO SG&AUX CELLS.
3    14    1  47.66 1.0   .01   0    8.32
10   14    1  95.32 1.0   .01   0    8.32
11   14    1  47.66 1.0   .01   0    8.32
12   14    1 142.97 1.0   .01   0    8.32
! AUX CELL DOOR.
8    14    1  3.25  2.0   .01   0    2.98
! OPEN CROSS VENT REAR RX BLDG TO PG.
10   2    1  2.37  2.0   .01   1    15.24
! VARIABLE CROSS VENT REAR RX BLDG TO PG.
10   2    7  7.11  2.0   .01   1    15.24
!  OPEN TRIP  CLOSE TRIP  BLOWN TRIP  ABLOWN
       9           3          10       5.52
!  OPEN TABLE TYPE TABLE  CLOSE TABLE TYPE TABLE
       3           2          3          2
12   2    7  9.47  2.0   .01   1    15.24
!  OPEN TRIP  CLOSE TRIP  BLOWN TRIP  ABLOWN
       9           3          10       7.36
!  OPEN TABLE TYPE TABLE  CLOSE TABLE TYPE TABLE
       3           2          3          2
! CROSS VENT BETWEEN REAR RX BLDG  AND PG
! 16.58 IS THE FULL OPEN AREA FROM PG TO RX BLDG AND 12.88
! IS THE FULL OPEN AREA FROM RX BLDG TO PG.  15513 IS THE DP (PA)
! TO SHEAR THE PIN AND OPEN THE DOOR FROM RX BLDG TO PG.
!
! SUMP BETWEEN PG AND SG CELLS
! ELEV=-6.4M;AREA=243.24-.1728*VOL(ADDED)
! IF 18.54 M**3 ADDED THEN SUMP PUMPS START .11 M**3/S PER SG CELL
3       14          6        40.54       2.0      .01      0      -6.4
!    MIN VOL   MAX VOL   SUMP   BLOWOUT
       90      1497.8     3       0
4       14          6        81.07       2.0      .01      0      -6.4
!    MIN VOL   MAX VOL   SUMP   BLOWOUT
       90      1497.8     3       0
6       14          6       121.61       2.0      .01      0      -6.4
!    MIN VOL   MAX VOL   SUMP   BLOWOUT
       90      1497.8     3       0
! FULL JUNCTIONS BETWEEN VOLUMES IN PG.
```

```
4       5        1       47.15      1.0     .01    0     -2.67
5       6        1       47.15      1.0     .01    0     -2.67
4       7        1      341.41      1.0     .01    1     -.46
5       8        1      195.09      1.0     .01    1     -.46
6       9        1      520.24      1.0     .01    1     -.46
7       8        1       60.59      1.0     .01    0     2.38
8       9        1       60.59      1.0     .01    0     2.38
7      10        1      341.41      1.0     .01    1     5.22
8      11        1      195.09      1.0     .01    1     5.22
9      12        1      520.24      1.0     .01    1     5.22
10     11        1       60.59      1.0     .01    0     8.06
11     12        1       60.59      1.0     .01    0     8.06
11     13        1       84.54      1.0     .01    1     10.9
! JUNCTIONS BETWEEN 3 AND OTHER PG VOL.
3       4        1       22.9       1.0     .01    0    -2.67
3       7        1       2.96       1.0     .01    0    -.064
3      10        1       32.21      1.0     .01    0     7.8
$ END OF JUNCTIONS
$ NO ICE CONDENSER
$ NO SUPPRESSION POOL
$ NO FANS
$ NO FAN COOLER
 !
 ! BEAM LENGTH AND VIEW FACTOR MATRICES
 !
 ! BEAM LENGTHS
 !
  6.854734      6.854734      6.854734      6.854734
 33*0.0
  6.854734      6.854734      6.854734
 33*0.0
  6.854734      6.854734
 33*0.0
  6.854734
 33*0.0
  6.840296      6.840296      6.840296      6.840296
 29*0.0
  6.840296      6.840296      6.840296
 29*0.0
  6.840296      6.840296
 29*0.0
  6.840296
 29*0.0
  6.552734      6.552734      6.552734
 26*0.0
  6.552734      6.552734
 26*0.0
  6.552734
 26*0.0
  5.099385      5.099385      5.099385
 23*0.0
  5.099385      5.099385
 23*0.0
```

```
 5.099385
23*0.0
 4.599079      4.599079
21*0.0
 4.599079
21*0.0
 5.083277      5.083277      5.083277
18*0.0
 5.083277      5.083277
18*0.0
 5.083277
18*0.0
 12.36602      12.36602
16*0.0
 12.36602
16*0.0
 13.37178      13.37178
14*0.0
 13.37178
14*0.0
 12.92971      12.92971
12*0.0
 12.92971
12*0.0
 7.822110      7.822110
10*0.0
 7.822110
10*0.0
 11.95939      11.95939
 8*0.0
 11.95939
 8*0.0
 8.245959      8.245959
 6*0.0
 8.245959
 6*0.0
 7.872269
 5*0.0
 7.930065      7.930065      7.930065
 2*0.0
 7.930065      7.930065
 2*0.0
 7.930065
 2*0.0
 2.100992      2.100992
 2.100992
!
! VIEW FACTORS
!
 0.0000000E+00  0.7046309      2.3775108E-02  0.2715940
33*0.0
 0.7016890      2.3675844E-02  0.2704601
33*0.0
```

```
2.3675842E-02  0.2704601
33*0.0
0.2704601
33*0.0
0.0000000E+00  0.7357934      2.3174856E-02  0.2410318
29*0.0
0.7305974      2.3011198E-02  0.2393296
29*0.0
2.3011200E-02  0.2393296
29*0.0
0.2393296
29*0.0
0.0000000E+00  0.7867396      0.2132604
26*0.0
0.7612606      0.2063539
26*0.0
0.2063538
26*0.0
0.0000000E+00  0.5150708      0.4849292
23*0.0
0.4725720      0.4449174
23*0.0
0.4449174
23*0.0
0.5284958      0.4715041
21*0.0
0.4715042
21*0.0
0.0000000E+00  0.5110129      0.4889871
18*0.0
0.4691618      0.4489399
18*0.0
0.4489399
18*0.0
0.9413933      5.8606748E-02
16*0.0
5.8606744E-02
16*0.0
0.9365746      6.3425377E-02
14*0.0
6.3425362E-02
14*0.0
0.9386481      6.1351877E-02
12*0.0
6.1351895E-02
12*0.0
0.9319013      6.8098679E-02
10*0.0
6.8098724E-02
10*0.0
0.8913333      0.1086666
 8*0.0
0.1086667
```

```
  8*0.0
 0.9266607      7.3339306E-02
  6*0.0
 7.3339343E-02
  6*0.0
  1.000000
  5*0.0
 0.0000000E+00  0.7341224      0.2658775
  2*0.0
 0.7237772      0.2621308
  2*0.0
 0.2621309
  2*0.0
 0.2620601      0.7379398
 0.7379399
!
! NUMBER OF SPRAY TRAINS
2
! FOR TRAIN 1 (IN RX BLDG C1 AND C2).
!
! NUMBER OF SOURCE COMPARTMENTS
2
! SOURCE COMPARTMENT, INJECTION TEMPERATURE (K), FLOW RATE (M**3/S),
! NUMBER OF DROP SIZES; FOR EACH DROP SIZE: FREQUENCY AND DIAMETER
! (MICRONS)
1 293.15 .26  2
.49   1400.
.51   1100.
!
2 293.15 .28  2
.65   1400.
.35   1100.
! FOR SPRAY CARRYOVER, THE SOURCE AND RECEIVING COMPARTMENTS AND THE
! FRACTION CARRIED OVER
!
$
! SPRAY COMPARTMENT AND SPRAY FALL HEIGHT (M)
1  12.65
2  24.1
$
!
! SPRAY ACTUATION CRITERIA FOR THIS TRAIN
!
! NUMBER OF TOP-LEVEL CRITERIA IN "OR" CONFIGURATION
2
! FOR EACH TOP CRITERIA, NUMBER OF 2ND-LEVEL CRITERIA IN "AND"
! CONFIGURATION, AND FOR EACH 2ND-LEVEL CRITERION,
! NUMBER OF COMPARTMENTS TO TEST AND, FOR EACH
! COMPARTMENT TO TEST, THE COMPARTMENT ID AND THE PRESSURE (PA)
! AND TEMPERATURE (K) SETPOINTS.  FINALLY, THE NUMBER OF
! COMPARTMENTS THAT MUST MEET THE SETPOINTS FOR THE CRITERIA
! TO BE MET
!
```

```
! TEST COMPARTMENT 1 AND 2 AND ACTUATE IF EITHER IS TRUE "OR".
!
! TEST COMPARTMENT 1 FOR 10 IN WG.
1
1
1 103813.3 0.
1
! TEST COMPARMENT 2 FOR 10 IN WG.
1
1
2 103813.3 0.
1
!
! DELAY TIME FOR SPRAYS TO START AFTER ACTUATION AND TIME FOR
! SPRAYS TO RUN AFTER STARTING
44. 1.0E10
!
! FOR TRAIN 2 (IN PG C3,C10,C11, AND C12).
!
! NUMBER OF SOURCE COMPARTMENTS
4
! SOURCE COMPARTMENT, INJECTION TEMPERATURE (K), FLOW RATE (M**3/S),
! NUMBER OF DROP SIZES; FOR EACH DROP SIZE: FREQUENCY AND DIAMETER
! (MICRONS)
3  293.15  .0076  1
1.0  1690.
!
10 293.15  .022   1
1.0  1690.
!
11 293.15  .0126  1
1.0  1690.
!
12 293.15  .0337  1
1.0  1690.
! FOR SPRAY CARRYOVER, THE SOURCE AND RECEIVING COMPARTMENTS AND THE
! FRACTION CARRIED OVER
!
10     7   1.0
7      4   1.0
11     8   1.0
8      5   1.0
12     9   1.0
9      6   1.0
$
! SPRAY COMPARTMENT AND SPRAY FALL HEIGHT (M)
3  15.8
4  4.42
5  4.42
6  4.42
7  5.68
8  5.68
9  5.68
```

```
10 5.68
11 5.68
12 5.68
$
!
! SPRAY ACTUATION CRITERIA FOR THIS TRAIN
!
! NUMBER OF CRITERIA IN "OR" CONFIGURATION
2
! FOR EACH TOP CRITERIA, NUMBER OF 2ND-LEVEL CRITERIA IN "AND"
! CONFIGURATION, AND FOR EACH 2ND-LEVEL CRITERION,
! NUMBER OF COMPARTMENTS TO TEST AND, FOR EACH
! COMPARTMENT TO TEST, THE COMPARTMENT ID AND THE PRESSURE (PA)
! AND TEMPERATURE (K) SETPOINTS.  FINALLY, THE NUMBER OF
! COMPARTMENTS THAT MUST MEET THE SETPOINTS FOR THE CRITERIA
! TO BE MET
!
! TEST PG COMP 10 "AND" SG CELLS OR PG COMP 12 "AND" SG CELLS FOR 10 IN
!
! TEST PG COMP 10 "AND" SG CELLS
1
2
10 103813.3 0.
14 103813.3 0.
2
! TEST PG COMP 12 "AND" SG CELLS
1
2
12 103813.3 0.
14 103813.3 0.
2
!
! DELAY TIME FOR SPRAYS TO START AFTER ACTUATION AND TIME FOR
! SPRAYS TO RUN AFTER STARTING
44.  1.0E10
! SPRAY HEAT EXCHANGER INFORMATION
$ NO SPRAY RECIRC
$ NO SUMP HEAT EXCHANGERS
!
500.   100.    ! SIMULATION TIME AND CPU  TIME REMAINING
!
! INITIAL CONDITIONS
!
! TBULK, PP(1-4), UX
! TEMP  STEAM   N2     O2     H   CONV GAS VEL
  339.  20500. 63850. 16975.  0.     .3
  339.  20500. 63850. 16975.  0.     .3
  322.  9350.  72660. 19315.  0.     .3
  322.  9350.  72660. 19315.  0.     .3
  322.  9350.  72660. 19315.  0.     .3
  322.  9350.  72660. 19315.  0.     .3
  322.  9350.  72660. 19315.  0.     .3
  322.  9350.  72660. 19315.  0.     .3
```

```
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
!
! INITIAL CONDITIONS FOR LEAKS
! TATM, PPATM(1-4)
300.  2798. 77836. 20691. 0.
!
! SOURCE DATA
!
! STEAM AND WATER
! COMP, -1 = CONST. SOURCE T, TEMP, SSRCC
  8            3                477.   0
! TIME   RATE     ENTHAPY
   0.0    0.0     9.0156E5
   0.1  16349.2   8.9179E5
   0.2  17620.2   8.9225E5
   0.4  18327.8   8.9272E5
   0.6  18465.6   8.9272E5
   1.0  18293.3   8.9295E5
   1.5  18282.4   8.9318E5
   2.0  18141.8   8.9388E5
   3.0  17964.4   8.9807E5
   5.0  17190.2   9.2714E5
   6.0  17003.3   9.5343E5
   7.0  16060.7   9.8529E5
   8.0  14970.3   1.0188E6
   9.0  14533.0   1.0516E6
  10.0  13689.3   1.0814E6
  12.0  11281.7   1.1290E6
  15.0  9411.10   1.1737E6
  20.0  8951.10   1.2221E6
  25.0  7414.40   1.2560E6
  30.0  5597.30   1.2837E6
  35.0  3980.70   1.3405E6
  40.0  2624.50   1.4593E6
  43.6  1808.00   1.4763E6
  45.0  2296.10   1.3707E6
  48.4  3859.10   1.0623E6
  50.0  4327.20   9.9739E5
  55.0  4388.00   9.7645E5
  59.0  4201.20   9.6901E5
  60.0  3568.80   1.0439E6
  62.0  3632.30   1.0123E6
  64.0  2805.00   1.1265E6
  66.0  2339.60   1.2023E6
  70.0  1996.70   1.2288E6
  75.0  983.400   1.7184E6
  78.0  1219.30   1.4335E6
```

```
  80.0  1246.50  1.4882E6
  84.0  743.000  1.9273E6
  87.0  825.530  1.7368E6
  90.0  840.050  1.6582E6
  93.0  844.580  1.5896E6
  99.0  879.060  1.4775E6
 106.0  876.790  1.4233E6
 112.0  808.300  1.4570E6
 118.0  702.160  1.5145E6
 124.0  699.440  1.5545E6
 134.0  361.060  2.4214E6
 145.0  146.060  2.6633E6
 150.0  64.4100  2.6865E6
 156.0  10.8860  2.7028E6
 156.5   0.0     2.7028E6
3600.0   0.0     2.7028E6
$
$
! NITROGEN
$
! OXYGEN
$
! HYDROGEN
! COMP, -1 = CONST. SOURCE T, TEMP, SSRCC
!   8         -1               1311.   0
    8         -1                477.   0
!      TIME          RATE
  +0.00000E+00, +0.00000E+00
  +1.60000E+02, +4.60000E-04
  +3.20000E+02, +9.20000E-04
  +4.80000E+02, +3.22000E-03
  +5.60000E+02, +1.10400E-02
  +6.40000E+02, +2.02400E-02
  +7.20000E+02, +3.31200E-02
  +8.00000E+02, +4.78400E-02
  +8.32000E+02, +5.15200E-02
  +8.80000E+02, +4.23200E-02
  +9.60000E+02, +3.49600E-02
  +1.12000E+03, +2.76000E-02
  +1.28000E+03, +2.24480E-02
  +1.44000E+03, +1.87680E-02
  +1.60000E+03, +1.69280E-02
  +1.76000E+03, +1.47200E-02
  +1.92000E+03, +1.32480E-02
  +2.08000E+03, +1.19600E-02
  +2.24000E+03, +1.08560E-02
  +2.40000E+03, +9.93600E-03
  +2.56000E+03, +9.01600E-03
  +2.72000E+03, +8.64800E-03
  +2.88000E+03, +8.28000E-03
  +3.04000E+03, +8.09600E-03
  +3.20000E+03, +7.91200E-03
  +3.36000E+03, +7.54400E-03
```

+3.52000E+03,	+7.36000E-03
+3.68000E+03,	+7.17600E-03
+3.84000E+03,	+6.99200E-03
+4.00000E+03,	+6.90000E-03
+4.16000E+03,	+6.80800E-03
+4.32000E+03,	+6.62400E-03
+4.48000E+03,	+6.44000E-03
+4.64000E+03,	+6.25600E-03
+4.80000E+03,	+5.98000E-03
+4.96000E+03,	+5.98000E-03
+5.12000E+03,	+5.88800E-03
+5.28000E+03,	+5.70400E-03
+5.44000E+03,	+5.61200E-03
+5.60000E+03,	+5.56600E-03
+5.76000E+03,	+5.56600E-03
+5.92000E+03,	+5.54300E-03
+6.08000E+03,	+5.52000E-03
+6.24000E+03,	+5.42800E-03
+6.40000E+03,	+5.33600E-03
+6.56000E+03,	+5.24400E-03
+6.72000E+03,	+5.15200E-03
+6.88000E+03,	+5.15200E-03
+7.04000E+03,	+5.06000E-03
+7.20000E+03,	+4.96800E-03
+7.36000E+03,	+4.78400E-03
+7.52000E+03,	+4.69200E-03
+7.68000E+03,	+4.60000E-03
+7.84000E+03,	+4.50800E-03
+8.00000E+03,	+4.41600E-03
+8.16000E+03,	+4.04800E-03
+8.32000E+03,	+3.95600E-03
+8.48000E+03,	+3.86400E-03
+8.64000E+03,	+3.77200E-03
+8.80000E+03,	+3.68000E-03
+8.96000E+03,	+3.58800E-03
+9.12000E+03,	+3.49600E-03
+9.28000E+03,	+3.40400E-03
+9.44000E+03,	+3.31200E-03
+9.60000E+03,	+3.31200E-03
+9.76000E+03,	+3.22000E-03
+9.92000E+03,	+3.12800E-03
+1.00800E+04,	+2.94400E-03
+1.02400E+04,	+2.76000E-03
+1.04000E+04,	+2.66800E-03
+1.05600E+04,	+2.57600E-03
+1.07200E+04,	+2.39200E-03
+1.08800E+04,	+2.30000E-03
+1.10400E+04,	+2.20800E-03
+1.12000E+04,	+2.11600E-03
+1.13600E+04,	+2.02400E-03
+1.15200E+04,	+1.93200E-03
+1.16800E+04,	+1.84000E-03
+1.18400E+04,	+1.74800E-03

```
  +1.20000E+04, +1.65600E-03
  +1.21600E+04, +1.56400E-03
  +1.23200E+04, +1.47200E-03
  +1.24800E+04, +1.38000E-03
  +1.26400E+04, +1.28800E-03
  +1.28000E+04, +1.19600E-03
  +1.29600E+04, +1.10400E-03
$
! DOUBLE HYDROGEN RATE FOR SENSITIVITY.
! HYDROGEN
! COMP, -1 = CONST. SOURCE T, TEMP, SSRCC
!   8          -1               1311.   0
!    8          -1                477.   0
!      TIME            RATE
!  +0.00000E+00, +0.00000E+00
!  +1.60000E+02, +9.20000E-04
!  +3.20000E+02, +1.84000E-03
!  +4.80000E+02, +6.44000E-03
!  +5.60000E+02, +2.20800E-02
!  +6.40000E+02, +4.04800E-02
!  +7.20000E+02, +6.62400E-02
!  +8.00000E+02, +9.56800E-02
!  +8.32000E+02, +1.03040E-01
!  +8.80000E+02, +8.46400E-02
!  +9.60000E+02, +6.99200E-02
!  +1.12000E+03, +5.52000E-02
!  +1.28000E+03, +4.48960E-02
!  +1.44000E+03, +3.75360E-02
!  +1.60000E+03, +3.38560E-02
!  +1.76000E+03, +2.94400E-02
!  +1.92000E+03, +2.64960E-02
!  +2.08000E+03, +2.39200E-02
!  +2.24000E+03, +2.17120E-02
!  +2.40000E+03, +1.98720E-02
!  +2.56000E+03, +1.80320E-02
!  +2.72000E+03, +1.72960E-02
!  +2.88000E+03, +1.65600E-02
!  +3.04000E+03, +1.61920E-02
!  +3.20000E+03, +1.58240E-02
!  +3.36000E+03, +1.50880E-02
!  +3.52000E+03, +1.47200E-02
!  +3.68000E+03, +1.43520E-02
!  +3.84000E+03, +1.39840E-02
!  +4.00000E+03, +1.38000E-02
!  +4.16000E+03, +1.36160E-02
!  +4.32000E+03, +1.32480E-02
!  +4.48000E+03, +1.28800E-02
!  +4.64000E+03, +1.25120E-02
!  +4.80000E+03, +1.19600E-02
!  +4.96000E+03, +1.19600E-02
!  +5.12000E+03, +1.17760E-02
!  +5.28000E+03, +1.14080E-02
!  +5.44000E+03, +1.12240E-02
```

```
!  +5.60000E+03, +1.11320E-02
!  +5.76000E+03, +1.11320E-02
!  +5.92000E+03, +1.10860E-02
!  +6.08000E+03, +1.10400E-02
!  +6.24000E+03, +1.08560E-02
!  +6.40000E+03, +1.06720E-02
!  +6.56000E+03, +1.04880E-02
!  +6.72000E+03, +1.03040E-02
!  +6.88000E+03, +1.03040E-02
!  +7.04000E+03, +1.01200E-02
!  +7.20000E+03, +9.93600E-03
!  +7.36000E+03, +9.56800E-03
!  +7.52000E+03, +9.38400E-03
!  +7.68000E+03, +9.20000E-03
!  +7.84000E+03, +9.01600E-03
!  +8.00000E+03, +8.83200E-03
!  +8.16000E+03, +8.09600E-03
!  +8.32000E+03, +7.91200E-03
!  +8.48000E+03, +7.72800E-03
!  +8.64000E+03, +7.54400E-03
!  +8.80000E+03, +7.36000E-03
!  +8.96000E+03, +7.17600E-03
!  +9.12000E+03, +6.99200E-03
!  +9.28000E+03, +6.80800E-03
!  +9.44000E+03, +6.62400E-03
!  +9.60000E+03, +6.62400E-03
!  +9.76000E+03, +6.44000E-03
!  +9.92000E+03, +6.25600E-03
!  +1.00800E+04, +5.88800E-03
!  +1.02400E+04, +5.52000E-03
!  +1.04000E+04, +5.33600E-03
!  +1.05600E+04, +5.15200E-03
!  +1.07200E+04, +4.78400E-03
!  +1.08800E+04, +4.60000E-03
!  +1.10400E+04, +4.41600E-03
!  +1.12000E+04, +4.23200E-03
!  +1.13600E+04, +4.04800E-03
!  +1.15200E+04, +3.86400E-03
!  +1.16800E+04, +3.68000E-03
!  +1.18400E+04, +3.49600E-03
!  +1.20000E+04, +3.31200E-03
!  +1.21600E+04, +3.12800E-03
!  +1.23200E+04, +2.94400E-03
!  +1.24800E+04, +2.76000E-03
!  +1.26400E+04, +2.57600E-03
!  +1.28000E+04, +2.39200E-03
!  +1.29600E+04, +2.20800E-03
!$
$
$ NO WATER REMOVAL FROM SUMPS
$ NO COMPARTMENT ENERGY SOURCES
$ NO CONTINUOUS BURNING COMPARTMENTS
!
```

```
! TRIP LOGIC FOR JUNCTIONS
!
! FALSE TRIP SET TO FALSE AT -10 SEC.
! TRIP  TYPE  LOCK IN   NUM TESTS
   3    -4      1          1
!  TIME  TEST
!   TRIP TEST   TIME
       0        -10.
$
! PRESSURE CHECK 2 IN WG IN RX BLDG C1 & C2 "OR" LOGIC.
! TRIP  TYPE  LOCK IN   NUM TESTS
   4     1      2          1
! PRESSURE TEST
!  COMP    PRESS
     1     101821.
     2     101821.
$
! PRESSURE CHECK 2 IN WG IN PG &SG CELLS A "AND" LOGIC.
!TRIP  TYPE  LOCK IN   NUM TESTS
  5     1      2          2
! PRESSURE TEST
!  COMP    PRESS
    10     101821.
    14     101821.
$
! PRESSURE CHECK 2 IN WG IN PG &SG CELLS B "AND" LOGIC.
! TRIP  TYPE  LOCK IN   NUM TESTS
   11    1      2          2
! PRESSURE TEST
!  COMP    PRESS
    12     101821.
    14     101821.
$
! OR PRESSURE CHECKS IN RX BLDG AND PG &SG.
! TRIP  TYPE  LOCK IN   NUM TESTS
   6     5      1          1
! TRIP TEST
!  TRIP     DUMMY
    4        0.
    5        0.
   11        0.
$
! TIMER (STARTS TIMER AFTER TRIP 6)
! TRIP  TYPE  LOCK IN   NUM TESTS
   19    6      1          1
! TIME TEST
!   TRIP  TIME
     6    150.
$
! TIMER (STARTS TIMER AFTER TRIP 19)
! TRIP  TYPE  LOCK IN   NUM TESTS
   7     6      1          1
! TIME TEST
```

```
!   TRIP  TIME
    19     55.
$
! PRESSURE TO OPEN FILTER VENT AND CLOSE SPECIAL STEAM VENT IF < 3 IN WG
! TRIP  TYPE  LOCK IN   NUM TESTS
   8    -1      2         2
! PRESSURE TEST
!  COMP   PRESS
     1    102071.
     2    102071.
$
! TIMER + PRESSURE CHECK.
!TRIP  TYPE  LOCK IN   NUM TESTS
  1     5      2          2
! TRIP TEST
!   TRIP    DUMMY
      7       0.
      8       0.
$
! PRESSURE TO OPEN SPECIAL STEAM VENT.
! TRIP  TYPE  LOCK IN   NUM TESTS
   12    1      1         1
! PRESSURE TEST
!  COMP   PRESS
     1   109941.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN RX BLDG C1.
! TRIP  TYPE  LOCK IN   NUM TESTS
   16    1      1         1
! PRESSURE TEST
!  COMP   PRESS
     1   115111.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN PG C3.
! TRIP  TYPE  LOCK IN   NUM TESTS
   17    1      1         1
! PRESSURE TEST
!  COMP   PRESS
     3   115111.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN PG C10.
! TRIP  TYPE  LOCK IN   NUM TESTS
   18    1      1         1
! PRESSURE TEST
!  COMP   PRESS
    10   115111.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN PG C12.
! TRIP  TYPE  LOCK IN   NUM TESTS
   20    1      1         1
! PRESSURE TEST
!  COMP   PRESS
    12   115111.
```

```
$
! LOCK IN TEST 1 AND CLOSE SPECIAL STEAM VENT.
! TRIP  TYPE  LOCK IN   NUM TESTS
  13    5      1          1
! TRIP TEST
!  TRIP  DUMMY
    1     0.
$
! SET TO OPPOSITE OF TEST 1.
! TRIP  TYPE  LOCK IN   NUM TESTS
  14   -5      2          1
! TRIP TEST
!    TRIP   DUMMY
      13     0.
$
! OPEN SPECIAL STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED).
! TRIP  TYPE  LOCK IN   NUM TESTS
  15    5      2          2
! TRIP TEST
!    TRIP  DUMMY
      14    0.
      12    0.
$
! LOCK IN TEST 19 AND CLOSE REGULAR STEAM VENTS.
! TRIP  TYPE  LOCK IN   NUM TESTS
  21    5      1          1
! TRIP TEST
!  TRIP  DUMMY
   19     0.
$
! SET TO OPPOSITE OF TEST 19.
! TRIP  TYPE  LOCK IN   NUM TESTS
  22   -5      2          1
! TRIP TEST
!    TRIP   DUMMY
      21     0.
$
! OPEN REGULAR STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED) IN RX
! TRIP  TYPE  LOCK IN   NUM TESTS
  23    5      2          2
! TRIP TEST
!    TRIP  DUMMY
      22    0.
      16    0.
$
! OPEN REGULAR STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED) IN PG
! TRIP  TYPE  LOCK IN   NUM TESTS
  24    5      2          2
! TRIP TEST
!    TRIP  DUMMY
      22    0.
      17    0.
$
```

```
! OPEN REGULAR STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED) IN PG
! TRIP  TYPE  LOCK IN   NUM TESTS
  25     5      2          2
! TRIP TEST
!    TRIP  DUMMY
      22     0.
      18     0.
$
! OPEN REGULAR STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED) IN PG
! TRIP  TYPE  LOCK IN   NUM TESTS
  26     5      2          2
! TRIP TEST
!    TRIP  DUMMY
      22     0.
      20     0.
$
! RECLOSE PRESSURE CHECK FOR FILTER VENT AT 15 IN WG.
! TRIP  TYPE  LOCK IN   NUM TESTS
  2      1      2          1
! PRESSURE TEST
!  COMP    PRESS
     1     105055.
     2     105055.
$
! TRUE TRIP SET TRUE AT -10 SEC.
! TRIP  TYPE  LOCK IN   NUM TESTS
  9      4      1          1
!  TRIP TEST  TIME
       0        -10.
$
! BLOWOUT OF RX BLDG TO PG VENT.
! TRIP  TYPE  LOCK IN   NUM TESTS
  10    -2      1          1
! PRESSURE TEST JUNCTION 10.
!  TRIP TEST   PRESS
       10     -15513.
$
$
! TABLES FOR JUNCTIONS
!
! OPEN TABLE FOR FILTER VENT
1
!  TIME  %OPEN
    0.     0.
   10.     1.
$
! CLOSE TABLE FOR FILTER VENT
2
!  TIME  %OPEN
    0.     1.
   10.     0.
$
! OPENING TABLE FOR RX BLDG TO PG VENT
```

```
3
! DIFF PRESS  %OPEN
      0.          0.
    373.          0.
    622.          1.
$
! OPEN TABLE FOR SPECIAL AND REGULAR STEAM VENTS.
4
! TIME   %OPEN
    0.      1.
$
! CLOSE TABLE FOR SPECIAL STEAM VENT.
5
! TIME   %OPEN
    0.      1.0
   15.        0.
$
! CLOSE TABLE FOR REGULAR STEAM VENT.
6
! TIME   %OPEN
    0.      1.0
   25.        0.
$
$
!  INITIAL WALL TEMPERATURES
!
2*339.
1*477.
3*339.
1*505.
1*339.
29*322.
!
! NAMELIST TYPE INPUT
!
! OUTPUT CONTROL VARIABLES
DELTFL = .001
DELVR = .1
! HYDROGEN IGNITION LIMITS
XHMNIG=1.0
! TIMESTEP CONTROL VARIABLES
!ESF CONTROLS
SPRAYS=AUTO
$
```

APPENDIX C

INPUT LISTING FOR CASE 4

```
! INITIAL NAMELIST TYPE INPUT
UOA = 9
CMPUTR = CRAY
$ END OF NAMELIST INPUT
!*********************************************
! PROBLEM GEOMETRY AND CONTAINMENT DESCRIPTION
!*********************************************
N REACTOR 38 VOL CASE 4$

THIS IS A 38 VOLUME DECK USED FOR CALCULATIONS OF
COMBUSTION RESPONSE AT N REACTOR

ALL SI UNITS




38 ! NUMBER OF COMPARTMENTS
!
! FOR EACH COMPARTMENT: AN ID, THE VOLUME (M**3), ELEVATION (M), FLAME
! PROPAGATION LENGTH (M), NUMBER OF SURFACES, AND INTEGERS
! SPECIFYING WHICH SUMP TO DUMP EXCESS WATER (FROM SUPERSATURATION)
! INTO AND WHICH SUMP THE SPRAYS FALL INTO.
!
C1-FRONTRXBLD
733.7    14.71 6.81   2 0 0
C2-FRONTRXBLD
638.93   14.71 6.20   2 1 1
C3-FRONTRXBLD
733.7    14.71 6.81   2 0 0
C4-FRONTRXBLD
909.5    15.01 6.81   2 0 0
C5-FRONTRXBLD
712.71   15.55 6.29   2 1 1
C6-FRONTRXBLD
909.5    15.01 6.81   2 0 0
C7-REARRXBLD
1203.    14.7  7.46   2 0 0
C8-REARRXBLD
801.57   14.7  6.31   2 2 2
C9-REARRXBLD
1203.    14.7  7.46   2 0 0
C10-FRONTRXBLD
1422.54 1.43   9.02   2 0 0
C11-FRONTRXBLD
736.19   0.62  8.13   3 1 1
C12-FRONTRXBLD
1422.54 1.43   9.02   2 0 0
C13-REARRXBLD
2472.74  2.37 9.02   2 0 0
C14-REARRXBLD
1297.76  4.14 9.02   3 2 2
```

```
C15-REARRXBLD
2705.69  1.86 9.02  2 0 0
C16-FRONT-PIPE-BS
1516.     7.05  18.3  2 0 0
C17-REAR-PIPE-BS
1516.     7.05  18.3  2 0 0
C18-GRAPHITE-GAS
240.4      6.1  5.64  1 0 0
C19-PIPE-GALL
2749.2   3.01  7.89  3 3 3
C20-PIPE-GALL
1761.2  -2.67  16.0  3 3 3
C21-PIPE-GALL
862.34  -2.67  9.14  2 3 3
C22-PIPE-GALL
2651.55 -2.67 24.38  3 3 3
C23-PIPE-GALL
1920.1   2.38  16.0  2 3 3
C24-PIPE-GALL
1096.3   2.38  9.14  2 3 3
C25-PIPE-GALL
2922.94  2.38 24.38  2 3 3
C26-PIPE-GALL
2090.85  8.06  16.0  2 3 3
C27-PIPE-GALL
1144.58  8.06  9.14  2 3 3
C28-PIPE-GALL
3118.53  8.06 24.38  2 3 3
C29-PRES-PENT
1189.15 18.21  7.32  1 3 3
C30-SGCELL6
6561.1   3.32 15.24  3 3 3
C31-SGCELL1
6561.1   3.32 15.24  3 3 3
C32-SGCELL2
6561.1   3.32 15.24  3 3 3
C33-AUXCELL
5699.93  2.97 12.04  3 4 4
C34-SGCELL3
6561.1   3.32 15.24  3 3 3
C35-SGCELL4
6561.1   3.32 15.24  3 3 3
C36-SGCELL5
6561.1   3.32 15.24  3 3 3
C37-FILTERBLD
3881.    8.35 141.3  2 0 0
C38-605
508.64  19.74 20.54  2 0 0
!
! FOR EACH SUMP: SUMP NUMBER, MAXIMUM VOLUME (M**3), SUMP NUMBER THAT
! THIS SUMP OVERFLOWS TO
!
! SUMP 1 IS UNDERNEATH THE ELEVATOR IN FRONT RX BLDG. WHEN IT FILLS
```

```
! WATER FLOWS ONTO THE FLOOR AND INTO DRAINS. IT IS REMOVED FROM THE RX
! BLDG.
1 16.9  0
! SUMP 2 IS THE BANANA WALL. IT HAS A VERY LARGE VOLUME SINCE IT
! CONNECTS TO THE FUEL POOL;HOWEVER WE NEGLECT THAT HERE AND CALCULATE
! THE VOLUME IN THE CAVITY ONLY. SINCE WHEN IT OVERFLOWS THE WATER GOES
! TO THE DRAINS AND IS REMOVED FROM THE RX BLDG, THE EFFECT IS THE SAME
! AS IF WE INCREASED THE VOLUME BUT DID NOT ADD IT TO THE ROOM VOLUME.
2 413.  0
! THERE ARE 6 SUMPS WHICH WE TREAT AS 1. THIS VOLUME IS LARGER THAN
! THE REAL VOL=1497 SINCE WE WANT THE CODE TO CONTINUE TO SUBTRACT THE
! VOLUME OF WATER FROM THE PG AND SG VOLUMES.
3 3000. 0
! SUMP 4 IS AN ARBITRARY SUMP IN THE AUX CELL SO THAT WATER WILL NOT
! LEAVE THE SYSTEM AND THE VOLUME OF WATER WILL BE SUBTRACTED FROM THE
! AUX CELL VOLUME.
4 2000. 0
$
!
! FOR EACH SURFACE: TYPE OF SURFACE, MASS OF SURFACE (KG), AREA OF
! SURFACE (M**2), CHARACTERISTIC LENGTH (M), SPECIFIC HEAT (J/KG/K),
! EMISSIVITY, INTEGER INDICATING WHICH SUMP THE CONDENSATE GOES INTO.
! FOR SLABS (STYPE = 1), THE NUMBER OF LAYERS IN THE SURFACE, AND FOR
! EACH, THE THICKNESS (M), THERMAL DIFFUSIVITY (M**2/S), AND THERMAL
! CONDUCTIVITY (W/M/K).  FINALLY, THE NODING INFORMATION AND BOUNDARY
! CONDITIONS ARE SPECIFIED (0'S INDICATE HECTR WILL DETERMINE
! THE VALUES INTERNALLY). NOTE THAT SOME OF THE NUMBERS SET TO 1.
! ARE NOT USED FOR THAT SURFACE TYPE.
!
! C1 SURFACES
!
CONC1
1 1. 275.85 6.25 1. .9  0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL1
2 29756.42 142.57 1. 531.7 .7 0
!
! C2 SURFACES
!
CONC2
1 1. 382.32 6.25 1. .9  1
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL2
2 25911.66 124.15 1. 531.7 .7 1
!
! C3 SURFACES
!
CONC3
1 1. 275.85 6.25 1. .9  0
```

```
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL3
2 29756.42 142.57 1. 531.7 .7 0
!
! C4 SURFACES
!
CONC4
1 1. 461.45 5.64 1. .9  0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL4
2 36884.67 176.73 1. 531.7 .7 0
!
! C5 SURFACES
!
CONC5
1 1. 376.61 4.57 1. .9  1
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL5
2 28903.75 138.49 1. 531.7 .7 1
!
! C6 SURFACES
!
CONC6
1 1. 461.45 5.64 1. .9  0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL6
2 36884.67 176.73 1. 531.7 .7 0
!
! C7 SURFACES
!
CONC7
1 1. 492.5 6.25 1. .9 0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL7
2 44433.37 180.63 1. 531.7 .7 0
!
! C8 SURFACES
!
CONC8
1 1. 460.53 6.25 1. .9 2
1
.3 1.6E-6 2.39
0 0. 0. 0.
```

```
STEEL8
2 29605.02 120.35 1. 531.7 .7 2
!
! C9 SURFACES
!
CONC9
1 1. 492.5 6.25 1. .9 0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL9
2 44433.37 180.63 1. 531.7 .7 0
!
! C10 SURFACES
!
CONC10
1 1. 833.08 18.04 1. .9  0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL10
2 57691.03 276.42 1. 531.7 .7 0
!
! C11 SURFACES
!
SUMP11
3 15000. 24.55 4.16 1. .94 1
CONC11
1 1. 305.20 16.26  1. .9  0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL11
2 29856.19 143.05 1. 531.7 .7 0
!
! C12 SURFACES
!
CONC12
1 1. 833.08 18.04 1. .9  0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL12
2 57691.03 276.42 1. 531.7 .7 0
!
! C13 SURFACES
!
CONC13
1 1. 1259.4 18.03 1. .9 0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL13
```

```
2 91329.27 371.27 1. 531.7 .7 0
!
! C14 SURFACES
!
SUMP14
3 400800. 42.6 5.03 1. .94 2
CONC14
1 1. 704.76 18.03 1. .9 2
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL14
2 47932.2 194.85 1. 531.7 .7 2
!
! C15 SURFACES
!
CONC15
1 1. 1111.84 18.03 1. .9 0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL15
2 99933.02 406.25 1. 531.7 .7 0
!
! C16 SURFACES
!
CONC16H
1 1. 139.8 9.1 1. .9 0
1
.3 1.6E-6 2.39
0 0. -1. 477.
STEEL16
2 50771.4 996.3 1. 531.7 .7 0
!
! C17 SURFACES
!
CONC17H
1 1. 139.8 9.1 1. .9 0
1
.3 1.6E-6 2.39
0 0. -1. 505.
STEEL17
2 50771.4 996.3 1. 531.7 .7 0
!
! C18 SURFACES
!
GRAPHITE18
2  1E10   92900. 11.28  1256.  .98  0
!
! C19 SURFACES
!
SUMP19
3 7515. 47.38 1.83 1. .94 3
```

```
CONC19
1 1. 1151. 15.78 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL19
2 76819.5 312. 1. 531.7 .7 3
!
! C20 SURFACES
!
SUMP20
3 15030. 94.77 1.83 1. .94 3
CONC20
1 1. 591.6 4.42 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL20
2 137122.8 556.98 1. 531.7 .7 3
!
! C21 SURFACES
!
CONC21
1 1. 356.74 4.42 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL21
2 78355.9 318.27 1. 531.7 .7 3
!
! C22 SURFACES
!
SUMP22
3 22545. 142.15 1.83 1. .94 3
CONC22
1 1. 886.96 4.42 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL22
2 208949. 848.73 1. 531.7 .7 3
!
! C23 SURFACES
!
CONC23
1 1. 526.22 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL23
2 8066. 32.76 1. 531.7 .7 3
!
! C24 SURFACES
```

```
!
CONC24
1 1. 276.43 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL24
2 4609.2 18.72 1. 531.7 .7 3
!
! C25 SURFACES
!
CONC25
1 1. 763.9 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL25
2 12291. 49.93 1. 531.7 .7 3
!
! C26 SURFACES
!
CONC26
1 1. 896.75 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL26
2 16132.1 65.53 1. 531.7 .7 3
!
! C27 SURFACES
!
CONC27
1 1. 307.1 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL27
2 9218.3 37.44 1. 531.7 .7 3
!
! C28 SURFACES
!
CONC28
1 1. 1261.63 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL28
2 24582.2 99.85 1. 531.7 .7 3
!
! C29 SURFACES
!
CONC29
1 1. 543.8 14.6 1. .9 3
```

```
1
.3 1.6E-6 2.39
0 0. 0. 0.
!
! C30 SURFACES
!
SUMP30
3 7515. 47.38 1.83 1. .94 3
CONC30
1 1. 2144.85 15.44 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL30
2 187096.6 785.66 1. 531.7 .7 3
!
! C31 SURFACES
!
SUMP31
3 7515. 47.38 1.83 1. .94 3
CONC31
1 1. 2144.85 15.44 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL31
2 187096.6 785.66 1. 531.7 .7 3
!
! C32 SURFACES
!
SUMP32
3 7515. 47.38 1.83 1. .94 3
CONC32
1 1. 2144.85 15.44 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL32
2 187096.6 785.66 1. 531.7 .7 3
!
! C33 SURFACES
!
SUMP33
3 0.0  1.0 1.0 1. .94 4
CONC33
1 1. 1941.42 15.47 1. .9 4
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL33
2 160044.5 650.1 1. 531.7 .7 4
!
! C34 SURFACES
```

```
!
SUMP34
3 7515. 47.38 1.83 1. .94 3
CONC34
1 1. 2144.85 15.44 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL34
2 187096.6 785.66 1. 531.7 .7 3
!
! C35 SURFACES
!
SUMP35
3 7515. 47.38 1.83 1. .94 3
CONC35
1 1. 2144.85 15.44 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL35
2 187096.6 785.66 1. 531.7 .7 3
!
! C36 SURFACES
!
SUMP36
3 7515. 47.38 1.83 1. .94 3
CONC36
1 1. 2144.85 15.44 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL36
2 187096.6 785.66 1. 531.7 .7 3
!
! C37 SURFACES
!
CONC37
1 1. 1742.7 68. 1. .94 0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL37
2 243071.5 4907.3 1. 531.7 .7 0
!
! C38 SURFACES
!
CONC38
1 1. 623.54 2.59 1. .94 0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL38
```

```
2 4259.97 83.59 1. 531.7 .7 0
!
!
! CONTAINMENT LEAKAGE INFORMATION
!
! NUMBER OF LEAKS, NUMBER OF PRESSURE AND TEMPERATURE-DEPENDENT
! LEAKAGE CURVES
!
! NOL  NOP  NOT
  25     1     0
! LEAK COMPARTMENT, TEMPERATURE-DEPENDENT LEAKAGE CURVE, PRESSURE-
! DEPENDENT LEAKAGE CURVE, CONTAINMENT FAILURE FLAG, CONTAINMENT
! FAILURE CRITERION, CONTAINMENT FAILURE AREA (M**2), LEAK ELEVATION
! (M), LEAK LOSS COEFFICIENT, L/A FOR LEAK (1/M)
!
! COMP  T CURVE  P CURVE  NCF    CRIT  AREA  ZJI   FLI     LA
! FILTERED RELEASE TO OUTSIDE.
  37      0        0       1       0.    14.3  61.6  1.0    .01
! LEAKS FROM SG CELLS AND AUX CELL.
  30      0        0       1       0.   .0267  -4.9  17.14 .01
  31      0        0       1       0.   .0267  -4.9  17.14 .01
  32      0        0       1       0.   .0267  -4.9  17.14 .01
  33      0        0       1       0.   .0267  -4.9  17.14 .01
  34      0        0       1       0.   .0267  -4.9  17.14 .01
  35      0        0       1       0.   .0267  -4.9  17.14 .01
  36      0        0       1       0.   .0267  -4.9  17.14 .01
  30      0        0       1       0.   .0007  10.7  1.0    .01
  31      0        0       1       0.   .0007  10.7  1.0    .01
  32      0        0       1       0.   .0007  10.7  1.0    .01
  33      0        0       1       0.   .0007  10.7  1.0    .01
  34      0        0       1       0.   .0007  10.7  1.0    .01
  35      0        0       1       0.   .0007  10.7  1.0    .01
  36      0        0       1       0.   .0007  10.7  1.0    .01
! VACUUM BREAKER FOR RX BLDG.
   6      0       -1       0   -1723.    1.3  17.8  1.6    .01
! VENT OPENS AT -1723 DIFF PRESS,FULL OPEN AT -3446.
! REGULAR STEAM VENT IN RX BLDG.
   4      0        0       5  115111.   2.63  17.8  1.74   .01
! VENT CLOSES AFTER 2 IN WG PRESSURE + 150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      30     19     4      1      6      1
! LEAK FROM PG TO OUTSIDE.
  22      0        0       1       0.    .003  -4.9  1.0    .01
! REGULAR STEAM VENTS IN PG C19(2).
  19      0        0       5  115111.   5.26  10.9  3.01   .01
! VENT CLOSES AFTER 2 IN WG PRESSURE + 150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      24     19     4      1      6      1
! REGULAR STEAM VENTS IN PG C26(4).
  26      0        0       5  115111.  10.52  10.9  3.01   .01
! VENT CLOSES AFTER 2 IN WG PRESSURE + 150 SEC.
```

```
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      25     19     4      1      6      1
! REGULAR STEAM VENTS IN PG C28(7).
   28      0          0      5  115111.  18.41  10.9  3.01  .01
! VENT CLOSES AFTER 2 IN WG PRESSURE + 150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      26     19     4      1      6      1
!
! VACUUM BREAKER IN PG.
   26      0         -1      0   -1723.    1.3  10.9  1.6   .01
! VENT OPENS AT -1723 DIFF PRESS, FULL OPEN AT -3446.
! LEAK FROM REAR RX BLDG.
  14       0          0      1       0.   .003  12.2  1.0   .01
! LEAK FROM FRONT RX BLDG.
  11       0          0      1       0.   .003  12.2  1.0   .01
! SPECIAL STEAM VENT IN RX BLDG.
   6       0          0      5  109941.   2.63  17.8  1.74  .01
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      15     13     4      1      5      1
! TABLE FOR VACUUM BREAKERS.
1    1
0.   10.   100.   1000.  1723.  2153.75  2584.5  3015.25  3446.  3876.75
1.0E-8 1.0E-8 1.0E-8 1.0E-8 1.0E-8 .325     .65      .975    1.3      1.3
0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
!
! FLOW JUNCTION DATA: COMPARTMENT ID'S, TYPE OF CONNECTION, FLOW
! AREA (M**2), LOSS COEFFICIENT, L/A RATIO (1/M), RELATIVE POSITION OF
! COMPARTMENTS, AND JUNCTION ELEVATION (M).
! ADDITIONAL INFORMATION IS PROVIDED FOR JUNCTION TYPE 7.
!
! FROM FRONT TO REAR RX BLDG.
4     7     1  24.2  1.395  .01   0    17.53
5     8     1  24.2  1.395  .01   0    17.53
6     9     1  24.2  1.395  .01   0    17.53
! JUNCTIONS TO C38.
4    38     1  7.804 2.0    .01   1    18.14
5    38     1  7.804 2.0    .01   1    18.14
6    38     1  7.804 2.0    .01   1    18.14
! JUNCTIONS FROM PIPE BARRIER SPACES.
16    1     5  14.6  2.76   .01   1    11.58
1448.5
16    3     5  14.6  2.76   .01   1    11.58
1448.5
17    7     5  14.6  2.76   .01   1    11.58
1448.5
17    9     5  14.6  2.76   .01   1    11.58
1448.5
! JUNCTIONS FROM GRAPHITE GAS SPACE.
17  18    5   .66   3.12   .01   0    2.130
20679.
```

```
! TO FILTER BLDG FROM RX BLDG (FILTER VENTS).
38   37  7    7.04  66.26  .01    0    19.74
!  OPEN TRIP  CLOSE TRIP  BLOWN TRIP  ABLOWN
      1            2            3         0.
!  OPEN TABLE  TYPE TABLE  CLOSE TABLE TYPE TABLE
      1            1            2          1
! DUCTS FROM PG TO SG & AUX CELLS.
19  30    1    47.66 1.0     .01    0     8.32
26  31    1    47.66 1.0     .01    0     8.32
26  32    1    47.66 1.0     .01    0     8.32
27  33    1    47.66 1.0     .01    0     8.32
28  34    1    47.66 1.0     .01    0     8.32
28  35    1    47.66 1.0     .01    0     8.32
28  36    1    47.66 1.0     .01    0     8.32
! AUX CELL DOOR.
24  33    1    3.25  2.0     .01    0     2.98
! OPEN CROSS VENT REAR RX BLDG TO PG.
26   7    1    2.37  2.0     .01    1     15.24
! VARIABLE CROSS VENT REAR RX BLDG TO PG.
26   7    7    7.11  2.0     .01    1     15.24
!  OPEN TRIP  CLOSE TRIP  BLOWN TRIP  ABLOWN
      9            3           10         5.52
!  OPEN TABLE TYPE TABLE  CLOSE TABLE TYPE TABLE
      3            2           3           2
28   9    7    9.47  2.0     .01    1     15.24
!  OPEN TRIP  CLOSE TRIP  BLOWN TRIP  ABLOWN
      9            3           27         7.36
!  OPEN TABLE TYPE TABLE  CLOSE TABLE TYPE TABLE
      3            2           3           2
! CROSS VENT BETWEEN REAR RX BLDG  AND PG
! 16.58 IS THE FULL OPEN AREA FROM PG TO RX BLDG AND 12.88
! IS THE FULL OPEN AREA FROM RX BLDG TO PG.  15513 IS THE DP (PA)
! TO SHEAR THE PIN AND OPEN THE DOOR FROM RX BLDG TO PG.
!
! SUMP BETWEEN PG AND SG CELLS
! DO NOT USE IN BASE CASE
! ELEV=-6.4M;AREA=243.24-.1728*VOL(ADDED)
! IF 18.54 M**3 ADDED THEN SUMP PUMPS START .11 M**3/S PER SG CELL
19       30          6         40.54       2.0       .01       0       -6.4
!     MIN VOL    MAX VOL   SUMP    BLOWOUT
       90        1497.8      3        0
26       31          6         40.54       2.0       .01       0       -6.4
!     MIN VOL    MAX VOL   SUMP    BLOWOUT
       90        1497.8      3        0
26       32          6         40.54       2.0       .01       0       -6.4
!     MIN VOL    MAX VOL   SUMP    BLOWOUT
       90        1497.8      3        0
28       34          6         40.54       2.0       .01       0       -6.4
!     MIN VOL    MAX VOL   SUMP    BLOWOUT
       90        1497.8      3        0
28       35          6         40.54       2.0       .01       0       -6.4
!     MIN VOL    MAX VOL   SUMP    BLOWOUT
       90        1497.8      3        0
```

```
28      36          6        40.54       2.0       .01      0       -6.4
!    MIN VOL    MAX VOL   SUMP    BLOWOUT
       90       1497.8     3        0
! FULL JUNCTIONS BETWEEN VOLUMES IN PG.
20      21          1        47.15       1.0       .01      0       -2.67
21      22          1        47.15       1.0       .01      0       -2.67
20      23          1       341.41       1.0       .01      1       -.46
21      24          1       195.09       1.0       .01      1       -.46
22      25          1       520.24       1.0       .01      1       -.46
23      24          1        60.59       1.0       .01      0       2.38
24      25          1        60.59       1.0       .01      0       2.38
23      26          1       341.41       1.0       .01      1       5.22
24      27          1       195.09       1.0       .01      1       5.22
25      28          1       520.24       1.0       .01      1       5.22
26      27          1        60.59       1.0       .01      0       8.06
27      28          1        60.59       1.0       .01      0       8.06
27      29          1        84.54       1.0       .01      1       10.9
! JUNCTIONS BETWEEN 3 AND OTHER PG VOL.
19      20          1        22.9        1.0       .01      0       -2.67
19      23          1        2.96        1.0       .01      0       -.064
19      26          1        32.21       1.0       .01      0       7.8
!FULL JUNCTIONS BETWEEN VOLUMES IN RX BLDG.
1       2           1        40.00       1.0       .01      0       14.71
2       3           1        40.00       1.0       .01      0       14.71
1       4           1        76.77       1.0       .01      0       15.01
2       5           1        56.67       1.0       .01      0       15.55
3       6           1        76.77       1.0       .01      0       15.01
1       10          1        48.06       1.0       .01      -1      11.58
2       11          1        50.88       1.0       .01      -1      11.58
3       12          1        48.06       1.0       .01      -1      11.58
4       5           1        54.37       1.0       .01      0       15.55
5       6           1        54.37       1.0       .01      0       15.55
7       8           1        53.33       1.0       .01      0       14.71
8       9           1        53.33       1.0       .01      0       14.71
7       13          1       130.23       1.0       .01      -1      11.6
8       14          1        71.16       1.0       .01      -1      11.6
9       15          1       130.23       1.0       .01      -1      11.6
10      11          1        42.46       1.0       .01      0       4.59
11      12          1        42.46       1.0       .01      0       4.59
13      14          1        94.18       1.0       .01      0       4.89
14      15          1        95.50       1.0       .01      0       4.89
$ END OF JUNCTIONS
$ NO ICE CONDENSER
$ NO SUPPRESSION POOL
$ NO FANS
$ NO FAN COOLER
 !
 ! BEAM LENGTH AND VIEW FACTOR MATRICES
 !
 ! BEAM LENGTHS
 !
   6.312604        6.312604
  84*0.0
```

```
 6.312604
84*0.0
 4.541529      4.541529
82*0.0
 4.541529
82*0.0
 6.312604      6.312604
80*0.0
 6.312604
80*0.0
 5.130527      5.130527
78*0.0
 5.130527
78*0.0
 4.981084      4.981084
76*0.0
 4.981084
76*0.0
 5.130527      5.130527
74*0.0
 5.130527
74*0.0
 6.433824      6.433824
72*0.0
 6.433824
72*0.0
 4.967724      4.967724
70*0.0
 4.967724
70*0.0
 6.433824      6.433824
68*0.0
 6.433824
68*0.0
 4.615723      4.615723
66*0.0
 4.615723
66*0.0
 5.605507      5.605507      5.605507
63*0.0
 5.605507      5.605507
63*0.0
 5.605507
63*0.0
 4.615723      4.615723
61*0.0
 4.615723
61*0.0
 5.459022      5.459022
59*0.0
 5.459022
59*0.0
 4.958487      4.958487      4.958487
```

```
56*0.0
 4.958487      4.958487
56*0.0
 4.958487
56*0.0
 6.416276      6.416276
54*0.0
 6.416276
54*0.0
 4.803802      4.803802
52*0.0
 4.803802
52*0.0
 4.803802      4.803802
50*0.0
 4.803802
50*0.0
9.3158232E-03
49*0.0
 6.552734      6.552734      6.552734
46*0.0
 6.552734      6.552734
46*0.0
 6.552734
46*0.0
 5.099385      5.099385      5.099385
43*0.0
 5.099385      5.099385
43*0.0
 5.099385
43*0.0
 4.599079      4.599079
41*0.0
 4.599079
41*0.0
 5.083277      5.083277      5.083277
38*0.0
 5.083277      5.083277
38*0.0
 5.083277
38*0.0
 12.36602      12.36602
36*0.0
 12.36602
36*0.0
 13.37178      13.37178
34*0.0
 13.37178
34*0.0
 12.92971      12.92971
32*0.0
 12.92971
32*0.0
```

```
 7.822110        7.822110
30*0.0
 7.822110
30*0.0
 11.95939        11.95939
28*0.0
 11.95939
28*0.0
 8.245959        8.245959
26*0.0
 8.245959
26*0.0
 7.872269
25*0.0
 7.931777        7.931777        7.931777
22*0.0
 7.931777        7.931777
22*0.0
 7.931777
22*0.0
 7.931777        7.931777        7.931777
19*0.0
 7.931777        7.931777
19*0.0
 7.931777
19*0.0
 7.931777        7.931777        7.931777
16*0.0
 7.931777        7.931777
16*0.0
 7.931777
16*0.0
 7.914981        7.914981        7.914981
13*0.0
 7.914981        7.914981
13*0.0
 7.914981
13*0.0
 7.931777        7.931777        7.931777
10*0.0
 7.931777        7.931777
10*0.0
 7.931777
10*0.0
 7.931777        7.931777        7.931777
 7*0.0
 7.931777        7.931777
 7*0.0
 7.931777
 7*0.0
 7.931777        7.931777        7.931777
 4*0.0
 7.931777        7.931777
```

```
 4*0.0
 7.931777
 4*0.0
 2.100992      2.100992
 2*0.0
 2.100992
 2*0.0
 2.589487      2.589487
 2.589487
!
! VIEW FACTORS
!
0.6592658     0.3407342
84*0.0
0.3407342
84*0.0
0.7548720     0.2451281
82*0.0
0.2451280
82*0.0
0.6592658     0.3407342
80*0.0
0.3407342
80*0.0
0.7230719     0.2769281
78*0.0
0.2769282
78*0.0
0.7311396     0.2688604
76*0.0
0.2688605
76*0.0
0.7230719     0.2769281
74*0.0
0.2769282
74*0.0
0.7316566     0.2683434
72*0.0
0.2683434
72*0.0
0.7928143     0.2071856
70*0.0
0.2071857
70*0.0
0.7316566     0.2683434
68*0.0
0.2683434
68*0.0
0.7508608     0.2491393
66*0.0
0.2491392
66*0.0
0.0000000E+00 0.6808701     0.3191299
```

63*0.0		
0.6435798	0.3016517	
63*0.0		
0.3016517		
63*0.0		
0.7508608	0.2491393	
61*0.0		
0.2491392		
61*0.0		
0.7723206	0.2276794	
59*0.0		
0.2276794		
59*0.0		
0.0000000E+00	0.7834061	0.2165938
56*0.0		
0.7463088	0.2063373	
56*0.0		
0.2063374		
56*0.0		
0.7323940	0.2676060	
54*0.0		
0.2676060		
54*0.0		
0.1230526	0.8769475	
52*0.0		
0.8769475		
52*0.0		
0.1230526	0.8769475	
50*0.0		
0.8769475		
50*0.0		
1.000000		
49*0.0		
0.0000000E+00	0.7867396	0.2132604
46*0.0		
0.7612606	0.2063539	
46*0.0		
0.2063538		
46*0.0		
0.0000000E+00	0.5150708	0.4849292
43*0.0		
0.4725720	0.4449174	
43*0.0		
0.4449174		
43*0.0		
0.5284958	0.4715041	
41*0.0		
0.4715042		
41*0.0		
0.0000000E+00	0.5110129	0.4889871
38*0.0		
0.4691618	0.4489399	
38*0.0		

```
0.4489399
38*0.0
0.9413933       5.8606748E-02
36*0.0
5.8606744E-02
36*0.0
0.9365746       6.3425377E-02
34*0.0
6.3425362E-02
34*0.0
0.9386481       6.1351877E-02
32*0.0
6.1351895E-02
32*0.0
0.9319013       6.8098679E-02
30*0.0
6.8098724E-02
30*0.0
0.8913333       0.1086666
28*0.0
0.1086667
28*0.0
0.9266607       7.3339306E-02
26*0.0
7.3339343E-02
26*0.0
 1.000000
25*0.0
0.0000000E+00   0.7319034       0.2680967
22*0.0
0.7200701       0.2637621
22*0.0
0.2637622
22*0.0
0.0000000E+00   0.7319034       0.2680967
19*0.0
0.7200701       0.2637621
19*0.0
0.2637622
19*0.0
0.0000000E+00   0.7319034       0.2680967
16*0.0
0.7200701       0.2637621
16*0.0
0.2637622
16*0.0
0.0000000E+00   0.7491434       0.2508566
13*0.0
0.7488543       0.2507598
13*0.0
0.2507598
13*0.0
0.0000000E+00   0.7319034       0.2680967
```

```
  10*0.0
  0.7200701      0.2637621
  10*0.0
  0.2637622
  10*0.0
  0.0000000E+00  0.7319034      0.2680967
   7*0.0
  0.7200701      0.2637621
   7*0.0
  0.2637622
   7*0.0
  0.0000000E+00  0.7319034      0.2680967
   4*0.0
  0.7200701      0.2637621
   4*0.0
  0.2637622
   4*0.0
  0.2620601      0.7379398
   2*0.0
  0.7379399
   2*0.0
  0.8817897      0.1182102
  0.1182103
!
! NUMBER OF SPRAY TRAINS
2
! FOR TRAIN 1 (IN RX BLDG C1,C3,C4,C6,C7,C8,AND C9).
!
! NUMBER OF SOURCE COMPARTMENTS
7
! SOURCE COMPARTMENT, INJECTION TEMPERATURE (K), FLOW RATE (M**3/S),
! NUMBER OF DROP SIZES; FOR EACH DROP SIZE: FREQUENCY AND DIAMETER
! (MICRONS)
1 293.15 .0687  2
.64   1400.
.36   1100.
!
3 293.15 .0687  2
.64   1400.
.36   1100.
!
4 293.15 .0613  2
.33   1400.
.67   1100.
!
6 293.15 .0613  2
.33   1400.
.67   1100.
!
7 293.15 .09597  2
.66   1400.
.34   1100.
!
```

```
8 293.15 .0881  2
.63   1400.
.37   1100.
!
9 293.15 .09597  2
.66   1400.
.34   1100.
! FOR SPRAY CARRYOVER, THE SOURCE AND RECEIVING COMPARTMENTS AND THE
! FRACTION CARRIED OVER
!
1     10     .74
3     12     .74
7     13     .63
8     14     .68
9     15     .63
$
! SPRAY COMPARTMENT AND SPRAY FALL HEIGHT (M)
1  6.096
3  6.096
4  5.486
6  5.486
7  6.096
8  6.096
9  6.096
10 17.526
12 17.526
13 18.044
14 11.98
15 18.044
$
!
! SPRAY ACTUATION CRITERIA FOR THIS TRAIN
!
! NUMBER OF TOP-LEVEL CRITERIA IN "OR" CONFIGURATION
1
! FOR EACH TOP CRITERIA, NUMBER OF 2ND-LEVEL CRITERIA IN "AND"
! CONFIGURATION, AND FOR EACH 2ND-LEVEL CRITERION,
! NUMBER OF COMPARTMENTS TO TEST AND, FOR EACH
! COMPARTMENT TO TEST, THE COMPARTMENT ID AND THE PRESSURE (PA)
! AND TEMPERATURE (K) SETPOINTS.  FINALLY, THE NUMBER OF
! COMPARTMENTS THAT MUST MEET THE SETPOINTS FOR THE CRITERIA
! TO BE MET
!
! TEST COMPARTMENT 1 OR 3 AND 7 OR 9 AND ACTUATE IF BOTH ARE TRUE "AND"
2
!
! TEST COMPARTMENT 1 OR 3 FOR 10 IN WG.
2
1 103813.3 0.
3 103813.3 0.
1
! TEST COMPARMENT 7 OR 9 FOR 10 IN WG.
2
```

```
7 103813.3 0.
9 103813.3 0.
1
!
! DELAY TIME FOR SPRAYS TO START AFTER ACTUATION AND TIME FOR
! SPRAYS TO RUN AFTER STARTING
44. 1.0E10
!
! FOR TRAIN 2 (IN PG C19,C26,C27 AND C28).
!
! NUMBER OF SOURCE COMPARTMENTS
4
! SOURCE COMPARTMENT, INJECTION TEMPERATURE (K), FLOW RATE (M**3/S),
! NUMBER OF DROP SIZES; FOR EACH DROP SIZE: FREQUENCY AND DIAMETER
! (MICRONS)
19 293.15  .0076  1
1.0  1690.
!
26 293.15  .022   1
1.0  1690.
!
27 293.15  .0126  1
1.0  1690.
!
28 293.15  .0337  1
1.0  1690.
! FOR SPRAY CARRYOVER, THE SOURCE AND RECEIVING COMPARTMENTS AND THE
! FRACTION CARRIED OVER
!
26    23   1.0
23    20   1.0
27    24   1.0
24    21   1.0
28    25   1.0
25    22   1.0
$
! SPRAY COMPARTMENT AND SPRAY FALL HEIGHT (M)
19  15.8
20  4.42
21  4.42
22  4.42
23  5.68
24  5.68
25  5.68
26  5.68
27  5.68
28  5.68
$
!
! SPRAY ACTUATION CRITERIA FOR THIS TRAIN
!
! NUMBER OF CRITERIA IN "OR" CONFIGURATION
1
```

```
! FOR EACH TOP CRITERIA, NUMBER OF 2ND-LEVEL CRITERIA IN "AND"
! CONFIGURATION, AND FOR EACH 2ND-LEVEL CRITERION,
! NUMBER OF COMPARTMENTS TO TEST AND, FOR EACH
! COMPARTMENT TO TEST, THE COMPARTMENT ID AND THE PRESSURE (PA)
! AND TEMPERATURE (K) SETPOINTS.  FINALLY, THE NUMBER OF
! COMPARTMENTS THAT MUST MEET THE SETPOINTS FOR THE CRITERIA
! TO BE MET
! TEST PG AND SG CELLS FOR 10 IN WG.
2
!
! TEST PG COMP 26 "OR" 28 FOR 10 IN WG.
!
2
26 103813.3 0.
28 103813.3 0.
1
! TEST SG CELLS FOR 10 IN WG.
6
30 103813.3 0.
31 103813.3 0.
32 103813.3 0.
34 103813.3 0.
35 103813.3 0.
36 103813.3 0.
1
!
! DELAY TIME FOR SPRAYS TO START AFTER ACTUATION AND TIME FOR
! SPRAYS TO RUN AFTER STARTING
44.  1.0E10
! SPRAY HEAT EXCHANGER INFORMATION
$ NO SPRAY RECIRC
$ NO SUMP HEAT EXCHANGERS
!
10000.   500.    ! SIMULATION TIME AND CPU  TIME REMAINING
!
! INITIAL CONDITIONS
!
! TBULK, PP(1-4), UX
! TEMP  STEAM    N2     O2      H   CONV GAS VEL
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
  339.  20500. 63850. 16975.  0.      .3
```

```
   339.   20500. 63850. 16975.   0.      .3
   477.   20500. 63850. 16975.   0.      .3
   505.   20500. 63850. 16975.   0.      .3
   644.       0. 80046. 21278.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   322.   9350.  72660. 19315.   0.      .3
   339.   20500. 63850. 16975.   0.      .3
! INITIAL CONDITIONS FOR LEAKS
! TATM, PPATM(1-4)
300.  2798. 77836. 20691. 0.
!
! SOURCE DATA
!
! STEAM AND WATER
! COMP, -1 = CONST. SOURCE T, TEMP, SSRCC
   16          3                477.   0
! TIME    RATE     ENTHAPY
    0.0     0.0     9.0156E5
    0.1   16349.2   8.9179E5
    0.2   17620.2   8.9225E5
    0.4   18327.8   8.9272E5
    0.6   18465.6   8.9272E5
    1.0   18293.3   8.9295E5
    1.5   18282.4   8.9318E5
    2.0   18141.8   8.9388E5
    3.0   17964.4   8.9807E5
    5.0   17190.2   9.2714E5
    6.0   17003.3   9.5343E5
    7.0   16060.7   9.8529E5
    8.0   14970.3   1.0188E6
    9.0   14533.0   1.0516E6
   10.0   13689.3   1.0814E6
   12.0   11281.7   1.1290E6
   15.0   9411.10   1.1737E6
   20.0   8951.10   1.2221E6
   25.0   7414.40   1.2560E6
```

```
  30.0  5597.30  1.2837E6
  35.0  3980.70  1.3405E6
  40.0  2624.50  1.4593E6
  43.6  1808.00  1.4763E6
  45.0  2296.10  1.3707E6
  48.4  3859.10  1.0623E6
  50.0  4327.20  9.9739E5
  55.0  4388.00  9.7645E5
  59.0  4201.20  9.6901E5
  60.0  3568.80  1.0439E6
  62.0  3632.30  1.0123E6
  64.0  2805.00  1.1265E6
  66.0  2339.60  1.2023E6
  70.0  1996.70  1.2288E6
  75.0  983.400  1.7184E6
  78.0  1219.30  1.4335E6
  80.0  1246.50  1.4882E6
  84.0  743.000  1.9273E6
  87.0  825.530  1.7368E6
  90.0  840.050  1.6582E6
  93.0  844.580  1.5896E6
  99.0  879.060  1.4775E6
 106.0  876.790  1.4233E6
 112.0  808.300  1.4570E6
 118.0  702.160  1.5145E6
 124.0  699.440  1.5545E6
 134.0  361.060  2.4214E6
 145.0  146.060  2.6633E6
 150.0  64.4100  2.6865E6
 156.0  10.8860  2.7028E6
 156.5   0.0     2.7028E6
3600.0   0.0     2.7028E6
$
$
! NITROGEN
$
! OXYGEN
$
! HYDROGEN
! COMP, -1 = CONST. SOURCE T, TEMP, SSRCC
!   16        -1              1311.   0
    16        -1               477.   0
!      TIME           RATE
  +0.00000E+00, +0.00000E+00
  +1.60000E+02, +4.60000E-04
  +3.20000E+02, +9.20000E-04
  +4.80000E+02, +3.22000E-03
  +5.60000E+02, +1.10400E-02
  +6.40000E+02, +2.02400E-02
  +7.20000E+02, +3.31200E-02
  +8.00000E+02, +4.78400E-02
  +8.32000E+02, +5.15200E-02
  +8.80000E+02, +4.23200E-02
```

+9.60000E+02, +3.49600E-02
+1.12000E+03, +2.76000E-02
+1.28000E+03, +2.24480E-02
+1.44000E+03, +1.87680E-02
+1.60000E+03, +1.69280E-02
+1.76000E+03, +1.47200E-02
+1.92000E+03, +1.32480E-02
+2.08000E+03, +1.19600E-02
+2.24000E+03, +1.08560E-02
+2.40000E+03, +9.93600E-03
+2.56000E+03, +9.01600E-03
+2.72000E+03, +8.64800E-03
+2.88000E+03, +8.28000E-03
+3.04000E+03, +8.09600E-03
+3.20000E+03, +7.91200E-03
+3.36000E+03, +7.54400E-03
+3.52000E+03, +7.36000E-03
+3.68000E+03, +7.17600E-03
+3.84000E+03, +6.99200E-03
+4.00000E+03, +6.90000E-03
+4.16000E+03, +6.80800E-03
+4.32000E+03, +6.62400E-03
+4.48000E+03, +6.44000E-03
+4.64000E+03, +6.25600E-03
+4.80000E+03, +5.98000E-03
+4.96000E+03, +5.98000E-03
+5.12000E+03, +5.88800E-03
+5.28000E+03, +5.70400E-03
+5.44000E+03, +5.61200E-03
+5.60000E+03, +5.56600E-03
+5.76000E+03, +5.56600E-03
+5.92000E+03, +5.54300E-03
+6.08000E+03, +5.52000E-03
+6.24000E+03, +5.42800E-03
+6.40000E+03, +5.33600E-03
+6.56000E+03, +5.24400E-03
+6.72000E+03, +5.15200E-03
+6.88000E+03, +5.15200E-03
+7.04000E+03, +5.06000E-03
+7.20000E+03, +4.96800E-03
+7.36000E+03, +4.78400E-03
+7.52000E+03, +4.69200E-03
+7.68000E+03, +4.60000E-03
+7.84000E+03, +4.50800E-03
+8.00000E+03, +4.41600E-03
+8.16000E+03, +4.04800E-03
+8.32000E+03, +3.95600E-03
+8.48000E+03, +3.86400E-03
+8.64000E+03, +3.77200E-03
+8.80000E+03, +3.68000E-03
+8.96000E+03, +3.58800E-03
+9.12000E+03, +3.49600E-03
+9.28000E+03, +3.40400E-03

```
  +9.44000E+03, +3.31200E-03
  +9.60000E+03, +3.31200E-03
  +9.76000E+03, +3.22000E-03
  +9.92000E+03, +3.12800E-03
  +1.00800E+04, +2.94400E-03
  +1.02400E+04, +2.76000E-03
  +1.04000E+04, +2.66800E-03
  +1.05600E+04, +2.57600E-03
  +1.07200E+04, +2.39200E-03
  +1.08800E+04, +2.30000E-03
  +1.10400E+04, +2.20800E-03
  +1.12000E+04, +2.11600E-03
  +1.13600E+04, +2.02400E-03
  +1.15200E+04, +1.93200E-03
  +1.16800E+04, +1.84000E-03
  +1.18400E+04, +1.74800E-03
  +1.20000E+04, +1.65600E-03
  +1.21600E+04, +1.56400E-03
  +1.23200E+04, +1.47200E-03
  +1.24800E+04, +1.38000E-03
  +1.26400E+04, +1.28800E-03
  +1.28000E+04, +1.19600E-03
  +1.29600E+04, +1.10400E-03
$
! DOUBLE HYDROGEN RATE FOR SENSITIVITY.
! HYDROGEN
! COMP, -1 = CONST. SOURCE T, TEMP, SSRCC
!   16          -1                 1311.   0
!   16          -1                  477.   0
!     TIME            RATE
!  +0.00000E+00, +0.00000E+00
!  +1.60000E+02, +9.20000E-04
!  +3.20000E+02, +1.84000E-03
!  +4.80000E+02, +6.44000E-03
!  +5.60000E+02, +2.20800E-02
!  +6.40000E+02, +4.04800E-02
!  +7.20000E+02, +6.62400E-02
!  +8.00000E+02, +9.56800E-02
!  +8.32000E+02, +1.03040E-01
!  +8.80000E+02, +8.46400E-02
!  +9.60000E+02, +6.99200E-02
!  +1.12000E+03, +5.52000E-02
!  +1.28000E+03, +4.48960E-02
!  +1.44000E+03, +3.75360E-02
!  +1.60000E+03, +3.38560E-02
!  +1.76000E+03, +2.94400E-02
!  +1.92000E+03, +2.64960E-02
!  +2.08000E+03, +2.39200E-02
!  +2.24000E+03, +2.17120E-02
!  +2.40000E+03, +1.98720E-02
!  +2.56000E+03, +1.80320E-02
!  +2.72000E+03, +1.72960E-02
!  +2.88000E+03, +1.65600E-02
```

```
! +3.04000E+03, +1.61920E-02
! +3.20000E+03, +1.58240E-02
! +3.36000E+03, +1.50880E-02
! +3.52000E+03, +1.47200E-02
! +3.68000E+03, +1.43520E-02
! +3.84000E+03, +1.39840E-02
! +4.00000E+03, +1.38000E-02
! +4.16000E+03, +1.36160E-02
! +4.32000E+03, +1.32480E-02
! +4.48000E+03, +1.28800E-02
! +4.64000E+03, +1.25120E-02
! +4.80000E+03, +1.19600E-02
! +4.96000E+03, +1.19600E-02
! +5.12000E+03, +1.17760E-02
! +5.28000E+03, +1.14080E-02
! +5.44000E+03, +1.12240E-02
! +5.60000E+03, +1.11320E-02
! +5.76000E+03, +1.11320E-02
! +5.92000E+03, +1.10860E-02
! +6.08000E+03, +1.10400E-02
! +6.24000E+03, +1.08560E-02
! +6.40000E+03, +1.06720E-02
! +6.56000E+03, +1.04880E-02
! +6.72000E+03, +1.03040E-02
! +6.88000E+03, +1.03040E-02
! +7.04000E+03, +1.01200E-02
! +7.20000E+03, +9.93600E-03
! +7.36000E+03, +9.56800E-03
! +7.52000E+03, +9.38400E-03
! +7.68000E+03, +9.20000E-03
! +7.84000E+03, +9.01600E-03
! +8.00000E+03, +8.83200E-03
! +8.16000E+03, +8.09600E-03
! +8.32000E+03, +7.91200E-03
! +8.48000E+03, +7.72800E-03
! +8.64000E+03, +7.54400E-03
! +8.80000E+03, +7.36000E-03
! +8.96000E+03, +7.17600E-03
! +9.12000E+03, +6.99200E-03
! +9.28000E+03, +6.80800E-03
! +9.44000E+03, +6.62400E-03
! +9.60000E+03, +6.62400E-03
! +9.76000E+03, +6.44000E-03
! +9.92000E+03, +6.25600E-03
! +1.00800E+04, +5.88800E-03
! +1.02400E+04, +5.52000E-03
! +1.04000E+04, +5.33600E-03
! +1.05600E+04, +5.15200E-03
! +1.07200E+04, +4.78400E-03
! +1.08800E+04, +4.60000E-03
! +1.10400E+04, +4.41600E-03
! +1.12000E+04, +4.23200E-03
! +1.13600E+04, +4.04800E-03
```

```
!  +1.15200E+04, +3.86400E-03
!  +1.16800E+04, +3.68000E-03
!  +1.18400E+04, +3.49600E-03
!  +1.20000E+04, +3.31200E-03
!  +1.21600E+04, +3.12800E-03
!  +1.23200E+04, +2.94400E-03
!  +1.24800E+04, +2.76000E-03
!  +1.26400E+04, +2.57600E-03
!  +1.28000E+04, +2.39200E-03
!  +1.29600E+04, +2.20800E-03
!$
$
$ NO WATER REMOVAL FROM SUMPS
$ NO COMPARTMENT ENERGY SOURCES
$ NO CONTINUOUS BURNING COMPARTMENTS
!
! TRIP LOGIC FOR JUNCTIONS
!
! FALSE TRIP SET TO FALSE AT -10 SEC.
! TRIP  TYPE  LOCK IN   NUM TESTS
   3    -4     1          1
!  TIME  TEST
!   TRIP TEST   TIME
       0        -10.
$
! PRESSURE CHECK 2 IN WG IN RX BLDG C1 & C3 "OR" LOGIC.
! TRIP  TYPE  LOCK IN   NUM TESTS
   4     1     2          1
! PRESSURE TEST
!  COMP   PRESS
     1    101821.
     3    101821.
$
! PRESSURE CHECK 2 IN WG IN RX BLDG C7 & C9 "OR" LOGIC.
! TRIP  TYPE  LOCK IN   NUM TESTS
   21    1     2          1
! PRESSURE TEST
!  COMP   PRESS
     7    101821.
     9    101821.
$
! PRESSURE CHECK 2 IN WG IN RX BLDG "AND" LOGIC.
! TRIP  TYPE  LOCK IN   NUM TESTS
  22     5     2          2
! TRIP TEST
!  TRIP    DUMMY
    4        0.
   21        0.
$
! PRESSURE CHECK 2 IN WG IN PG "OR" LOGIC.
!TRIP  TYPE  LOCK IN   NUM TESTS
  5     1     2          1
! PRESSURE TEST
```

```
!  COMP    PRESS
    26     101821.
    28     101821.
$
! PRESSURE CHECK 2 IN WG IN SG CELLS "OR" LOGIC.
! TRIP  TYPE  LOCK IN   NUM TESTS
   11    1      2          1
! PRESSURE TEST
!  COMP    PRESS
    30     101821.
    31     101821.
    32     101821.
    34     101821.
    35     101821.
    36     101821.
$
! PRESSURE CHECK 2 IN WG IN PG & SG CELLS "AND" LOGIC.
! TRIP  TYPE  LOCK IN   NUM TESTS
   23    5      2          2
! TRIP TEST
!  TRIP     DUMMY
    5         0.
   11         0.
$
! OR PRESSURE CHECKS IN RX BLDG AND PG &SG.
! TRIP  TYPE  LOCK IN   NUM TESTS
   6     5      1          1
! TRIP TEST
!  TRIP     DUMMY
   22         0.
   23         0.
$
! TIMER (STARTS TIMER AFTER TRIP 6)
! TRIP  TYPE  LOCK IN   NUM TESTS
   19    6      1          1
! TIME TEST
!   TRIP  TIME
     6    150.
$
! TIMER (STARTS TIMER AFTER TRIP 19)
! TRIP  TYPE  LOCK IN   NUM TESTS
   7     6      1          1
! TIME TEST
!   TRIP  TIME
    19      55.
$
! PRESSURE TO OPEN FILTER VENT AND CLOSE SPECIAL STEAM VENT IF < 3 IN WG
! TRIP  TYPE  LOCK IN   NUM TESTS
   8    -1      2          4
! PRESSURE TEST
!  COMP    PRESS
     1    102071.
     3    102071.
```

```
     7     102071.
     9     102071.
$
! TIMER + PRESSURE CHECK.
!TRIP   TYPE   LOCK IN    NUM TESTS
  1      5       2          2
! TRIP TEST
!    TRIP     DUMMY
       7        0.
       8        0.
$
! PRESSURE TO OPEN SPECIAL STEAM VENT IN RX BLDG C6.
! TRIP   TYPE   LOCK IN    NUM TESTS
   12     1       1          1
! PRESSURE TEST
!   COMP    PRESS
      6    109941.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN RX BLDG C4.
! TRIP   TYPE   LOCK IN    NUM TESTS
   16     1       1          1
! PRESSURE TEST
!   COMP    PRESS
      4    115111.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN PG C19.
! TRIP   TYPE   LOCK IN    NUM TESTS
   17     1       1          1
! PRESSURE TEST
!   COMP    PRESS
     19    115111.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN PG C26.
! TRIP   TYPE   LOCK IN    NUM TESTS
   18     1       1          1
! PRESSURE TEST
!   COMP    PRESS
     26    115111.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN PG C28.
! TRIP   TYPE   LOCK IN    NUM TESTS
   20     1       1          1
! PRESSURE TEST
!   COMP    PRESS
     28    115111.
$
! LOCK IN TEST 1 AND CLOSE SPECIAL STEAM VENT.
! TRIP   TYPE   LOCK IN    NUM TESTS
   13     5       1          1
! TRIP TEST
!   TRIP   DUMMY
      1      0.
$
```

```
! SET TO OPPOSITE OF TEST 1.
! TRIP  TYPE  LOCK IN   NUM TESTS
  14    -5      2         1
! TRIP TEST
!    TRIP   DUMMY
      13     0.
$
! OPEN SPECIAL STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED).
! TRIP  TYPE  LOCK IN   NUM TESTS
  15     5      2         2
! TRIP TEST
!    TRIP  DUMMY
      14    0.
      12    0.
$
! LOCK IN TEST 19 AND CLOSE REGULAR STEAM VENTS.
! TRIP  TYPE  LOCK IN   NUM TESTS
  28     5      1         1
! TRIP TEST
!  TRIP  DUMMY
    19    0.
$
! SET TO OPPOSITE OF TEST 19.
! TRIP  TYPE  LOCK IN   NUM TESTS
  29    -5      2         1
! TRIP TEST
!    TRIP   DUMMY
      28     0.
$
! OPEN REGULAR STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED) IN RX
! TRIP  TYPE  LOCK IN   NUM TESTS
  30     5      2         2
! TRIP TEST
!    TRIP  DUMMY
      29    0.
      16    0.
$
! OPEN REGULAR STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED) IN PG
! TRIP  TYPE  LOCK IN   NUM TESTS
  24     5      2         2
! TRIP TEST
!    TRIP  DUMMY
      29    0.
      17    0.
$
! OPEN REGULAR STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED) IN PG
! TRIP  TYPE  LOCK IN   NUM TESTS
  25     5      2         2
! TRIP TEST
!    TRIP  DUMMY
      29    0.
      18    0.
$
```

```
! OPEN REGULAR STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED) IN PG
! TRIP  TYPE  LOCK IN   NUM TESTS
  26     5      2          2
! TRIP TEST
!    TRIP  DUMMY
      29     0.
      20     0.
$
! RECLOSE PRESSURE CHECK FOR FILTER VENT AT 15 IN WG.
! TRIP  TYPE  LOCK IN   NUM TESTS
  2      1      2          1
! PRESSURE TEST
!  COMP    PRESS
     1     105055.
     3     105055.
     7     105055.
     9     105055.
$
! TRUE TRIP SET TRUE AT -10 SEC.
! TRIP  TYPE  LOCK IN   NUM TESTS
  9      4      1          1
!  TRIP TEST  TIME
      0        -10.
$
! BLOWOUT OF RX BLDG TO PG VENT.
! TRIP  TYPE  LOCK IN   NUM TESTS
  10     -2     1          1
! PRESSURE TEST JUNCTION 22.
!  JUNCTION     PRESS
      22       -15513.
$
! BLOWOUT OF RX BLDG TO PG VENT.
! TRIP  TYPE  LOCK IN   NUM TESTS
  27     -2     1          1
! PRESSURE TEST JUNCTION 23.
!  JUNCTION     PRESS
      23       -15513.
$
$
! TABLES FOR JUNCTIONS
!
! OPEN TABLE FOR FILTER VENT
1
!  TIME  %OPEN
    0.     0.
   10.     1.
$
! CLOSE TABLE FOR FILTER VENT
2
!  TIME  %OPEN
    0.     1.
   10.     0.
$
```

```
! OPENING TABLE FOR RX BLDG TO PG VENT
3
! DIFF PRESS   %OPEN
      0.         0.
    373.         0.
    622.         1.
$
! OPEN TABLE FOR SPECIAL AND REGULAR STEAM VENTS.
4
! TIME   %OPEN
    0.      1.
$
! CLOSE TABLE FOR SPECIAL STEAM VENT.
5
! TIME   %OPEN
    0.      1.0
   15.        0.
$
! CLOSE TABLE FOR REGULAR STEAM VENT.
6
! TIME   %OPEN
    0.      1.0
   25.        0.
$
$
! INITAL WALL TEMPERATURES
!
32*339.
2*477.
2*505.
1*644.
47*322.
2*339.
!
! NAMELIST TYPE INPUT
!
! OUTPUT CONTROL VARIABLES
DELTFL = .01
DELVR = .1
! HYDROGEN IGNITION LIMITS
XHMNIG=1.0
! TIMESTEP CONTROL VARIABLES
!ESF CONTROLS
SPRAYS=AUTO
$
```

APPENDIX D

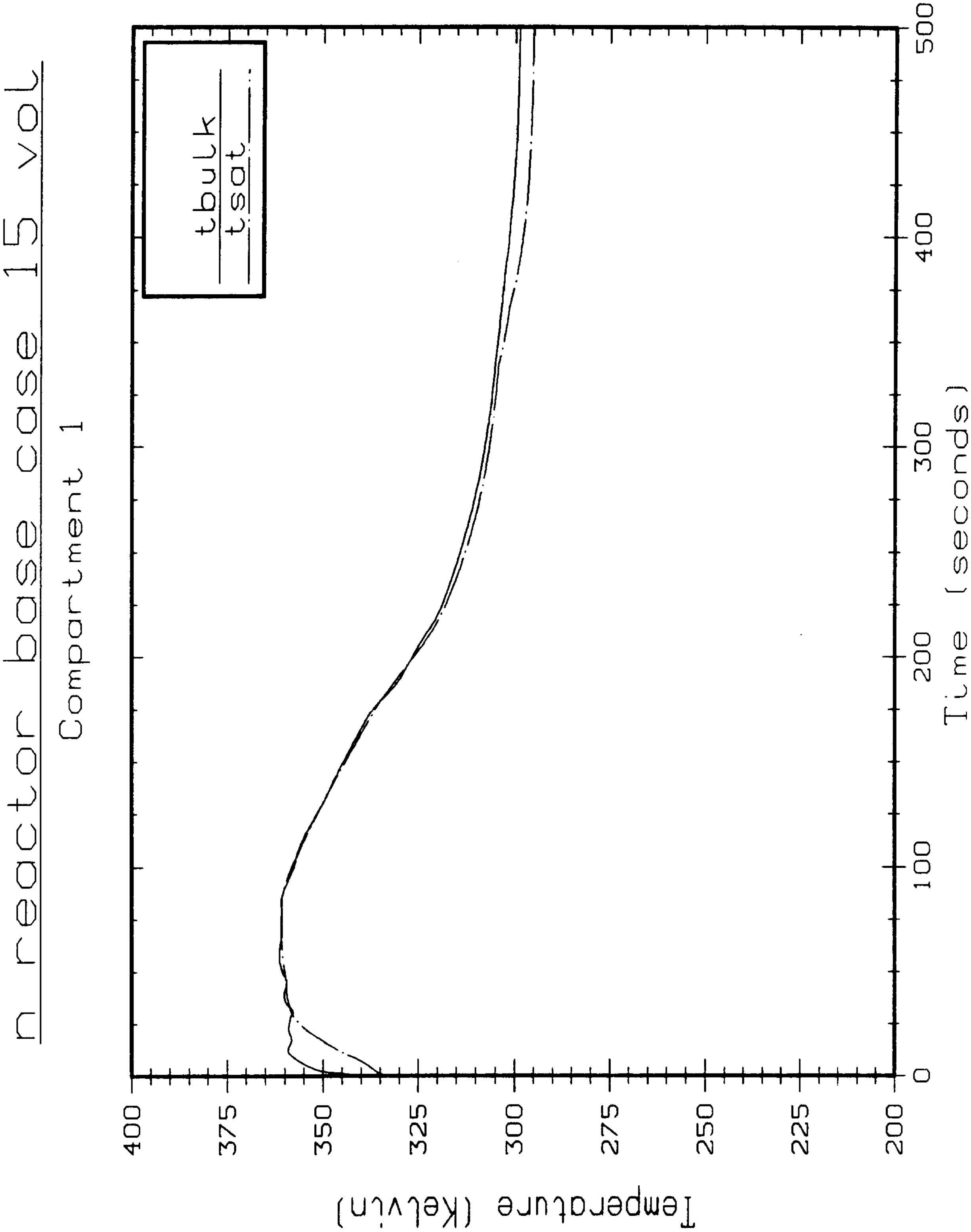
SELECTED PLOTS

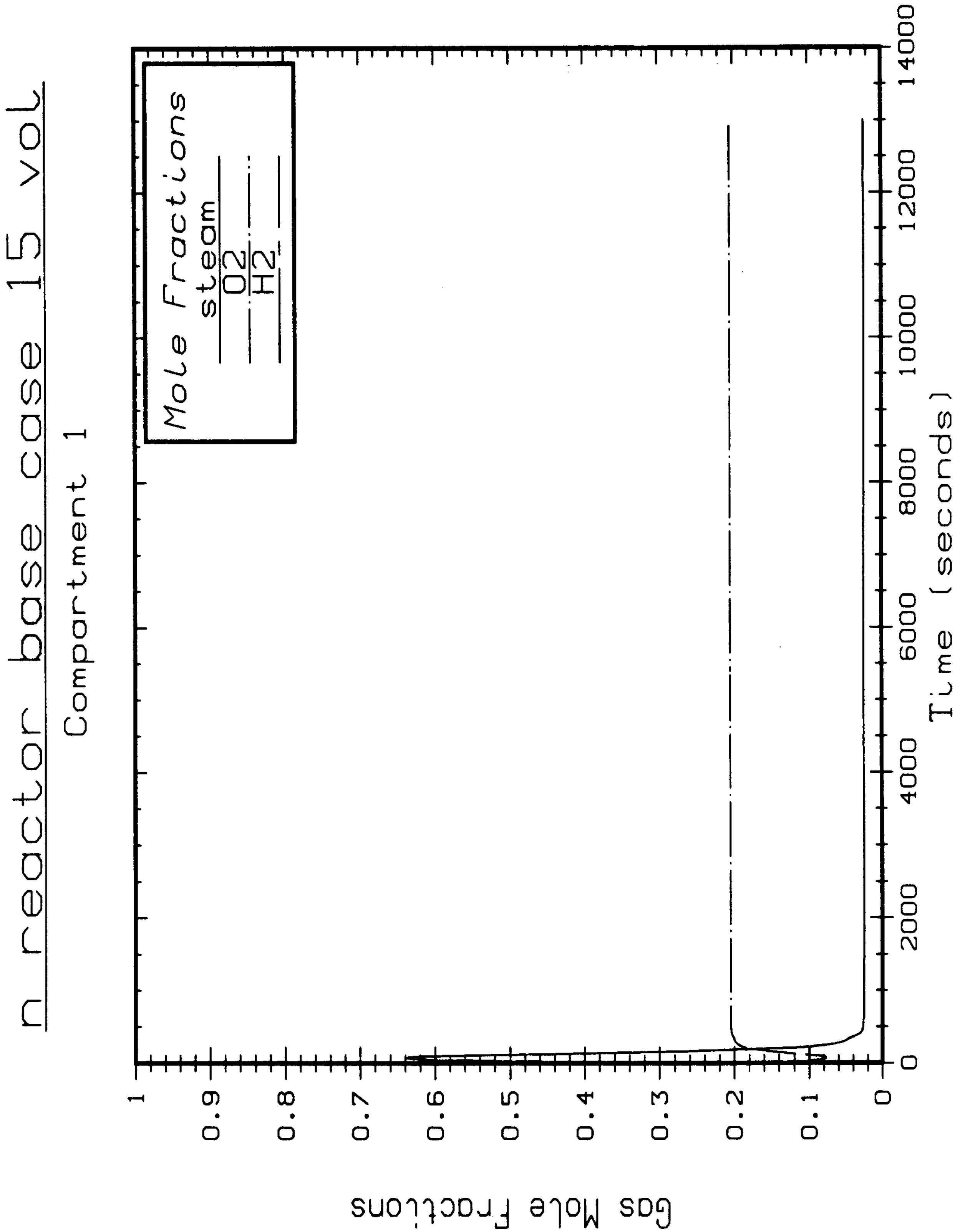
TABLE OF CONTENTS

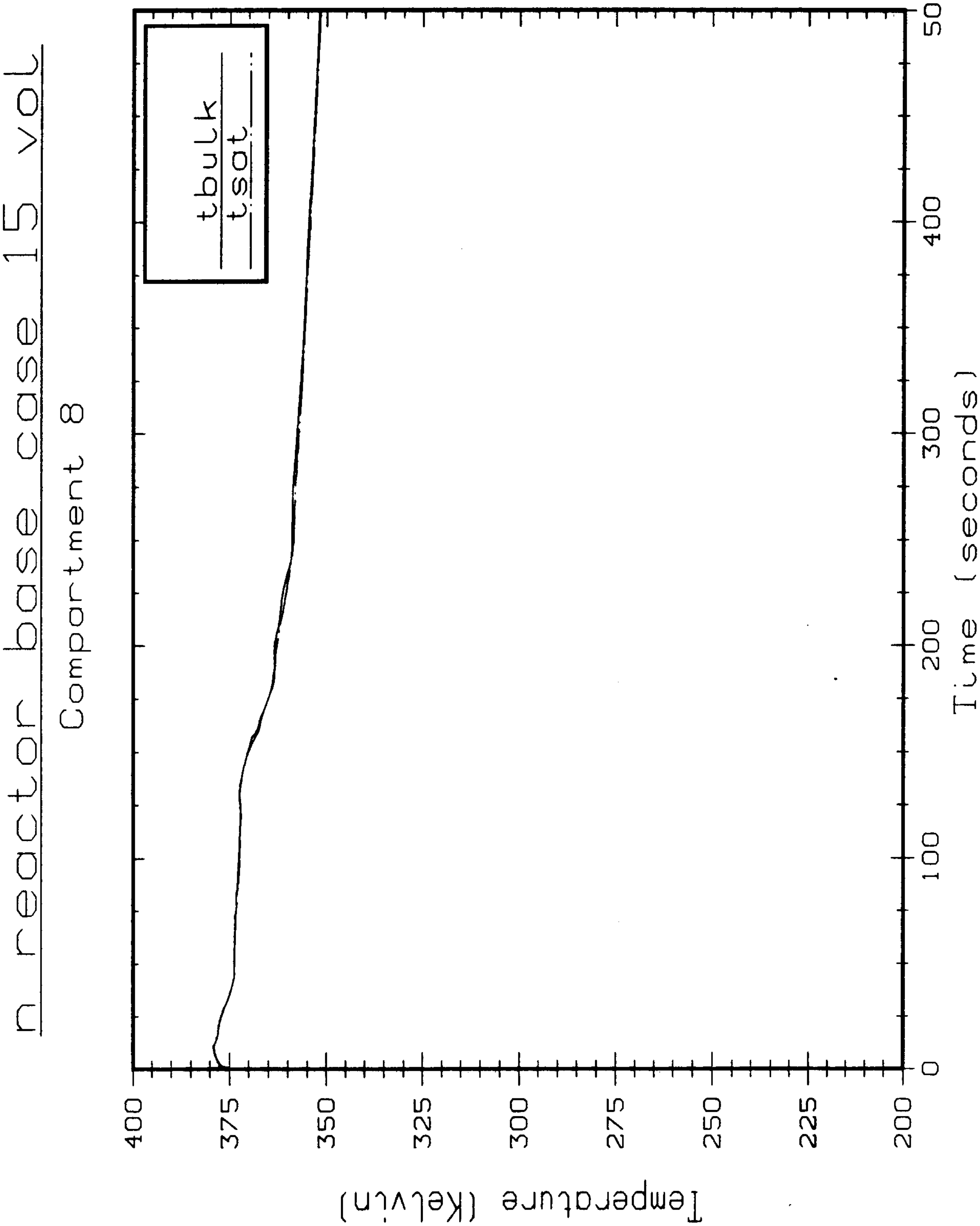
APPENDIX D

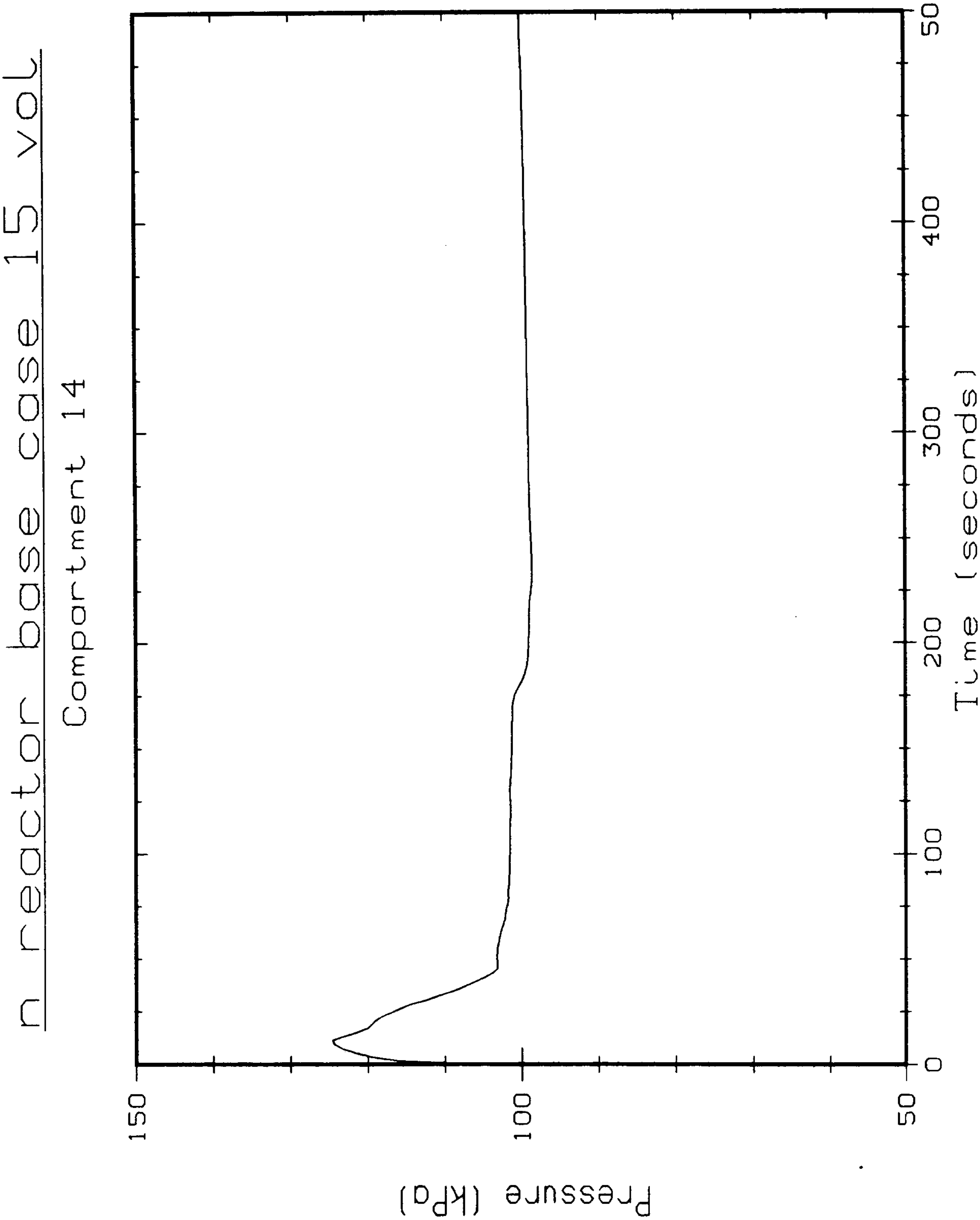
SELECTED PLOTS

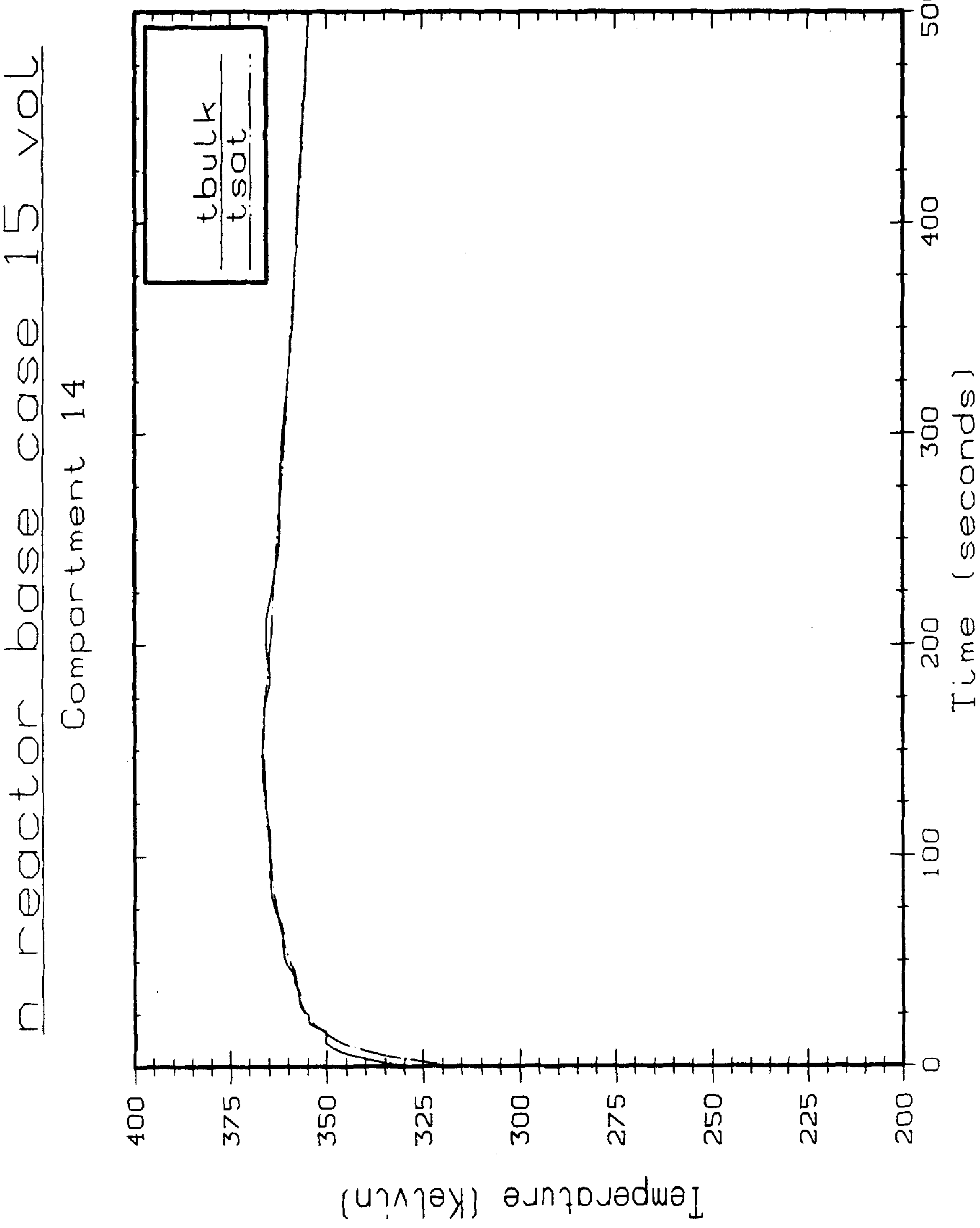
CASE 1

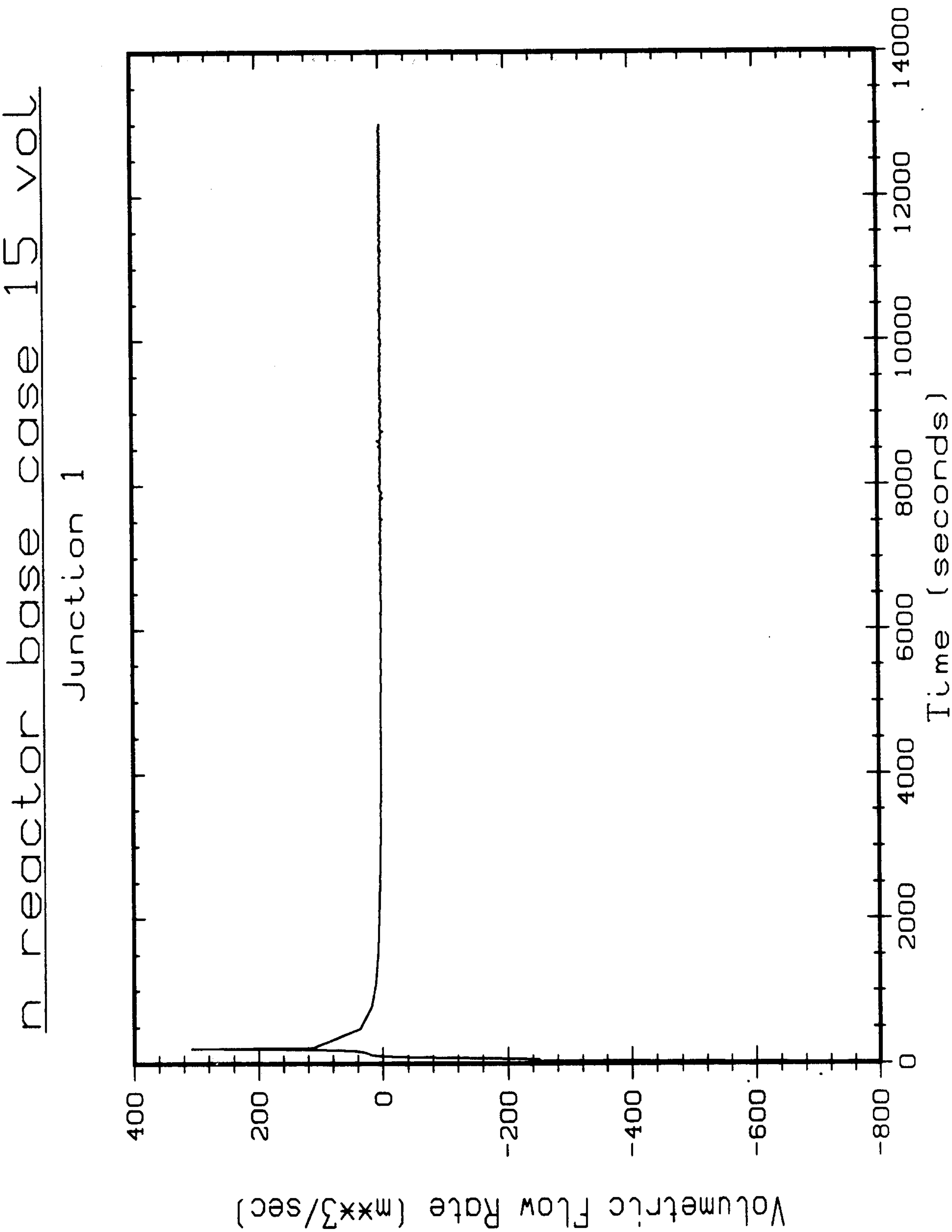

n reactor base case 15 vol
Compartment 1
tbulk
tsat
Temperature (Kelvin)
Time (seconds)
400
375
350
325
300
275
250
225
200
0
100
200
300
400
500

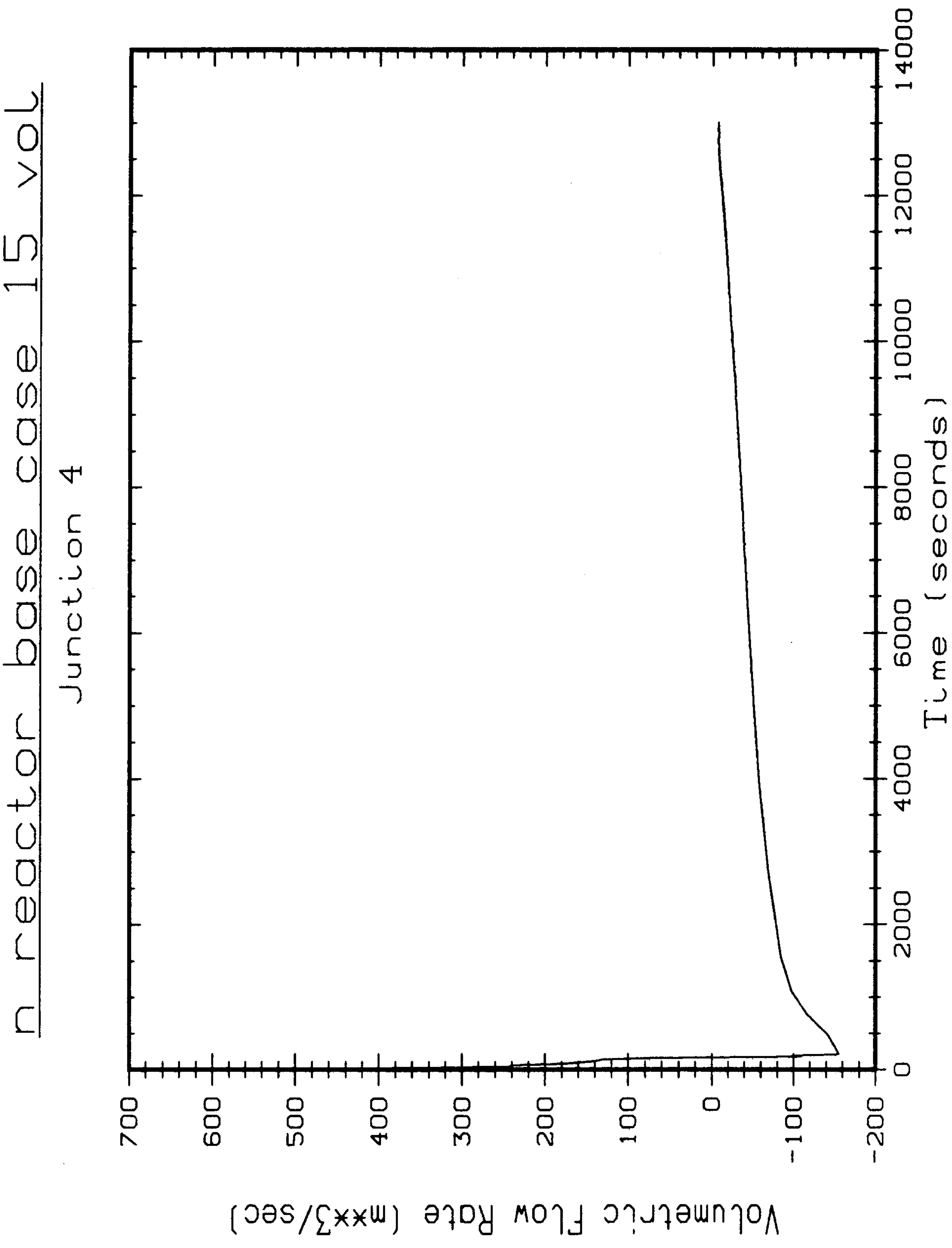

n reactor base case 15 vol
Compartment 1
Mole Fractions
steam
O2
H2
Time (seconds)
Gas Mole Fractions
0
2000
4000
6000
8000
10000
12000
14000
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

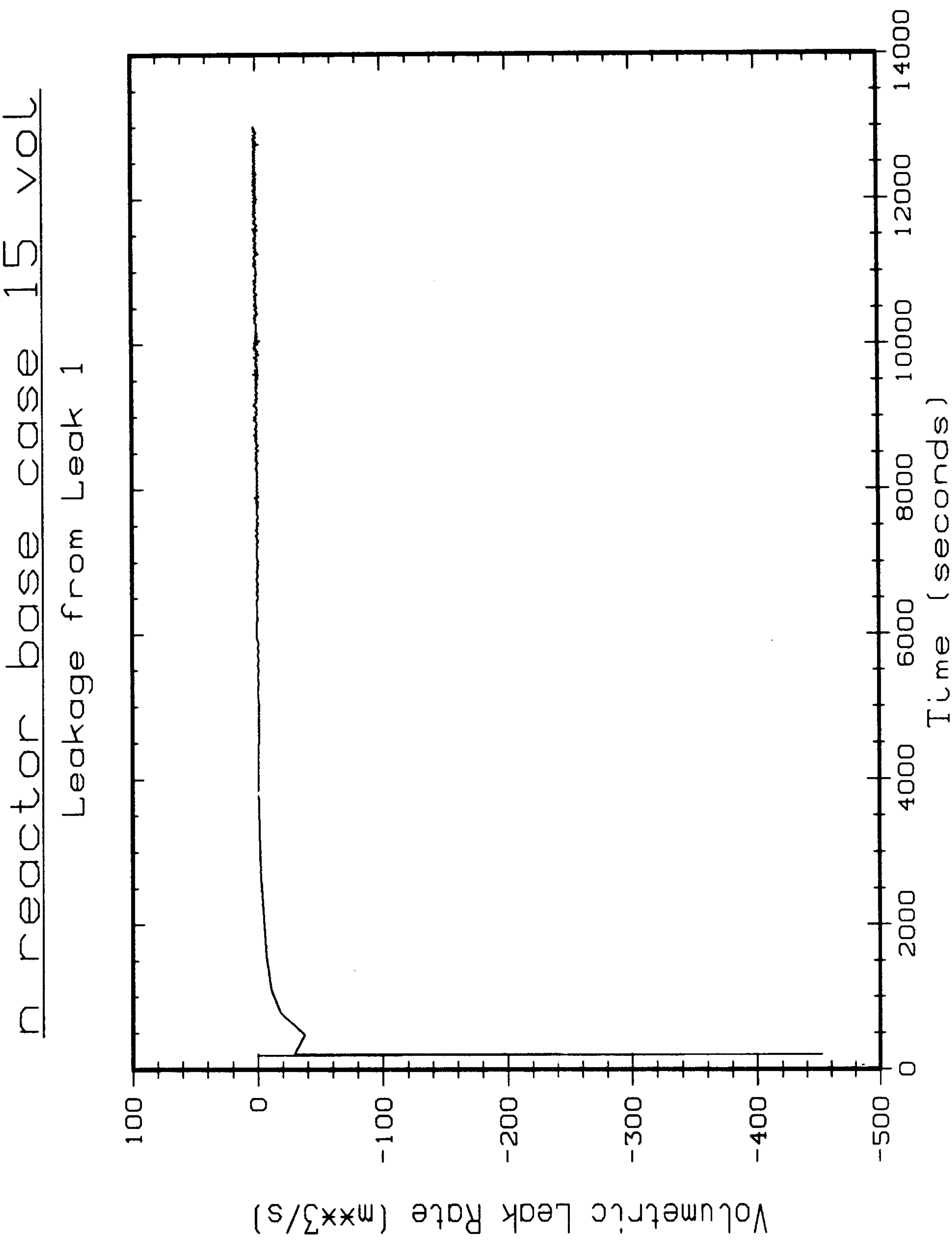

n reactor base case 15 vol
Compartment 8
tbulk
tsat
Temperature (Kelvin)
400
375
350
325
300
275
250
225
200
0
100
200
300
400
500
Time (seconds)


n reactor base case 15 vol
Compartment 14
Pressure (kPa)
150
100
50
Time (seconds)
0
100
200
300
400
500


n reactor base case 15 vol
Compartment 14
tbulk
tsat
Temperature (Kelvin)
Time (seconds)
400
375
350
325
300
275
250
225
200
0
100
200
300
400
500

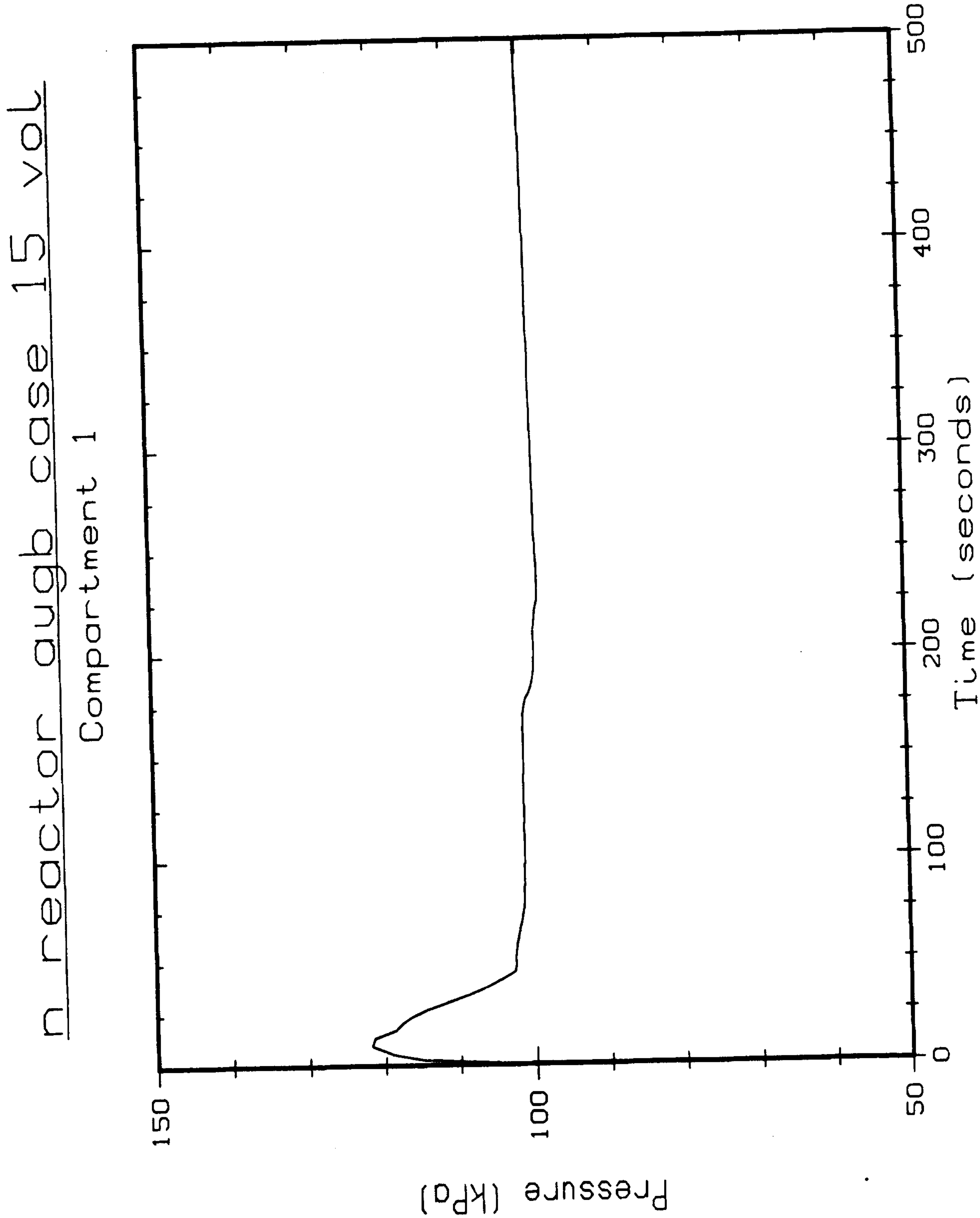

n reactor base case 15 vol
Junction 1
Volumetric Flow Rate (m**3/sec)
400
200
0
-200
-400
-600
-800
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000

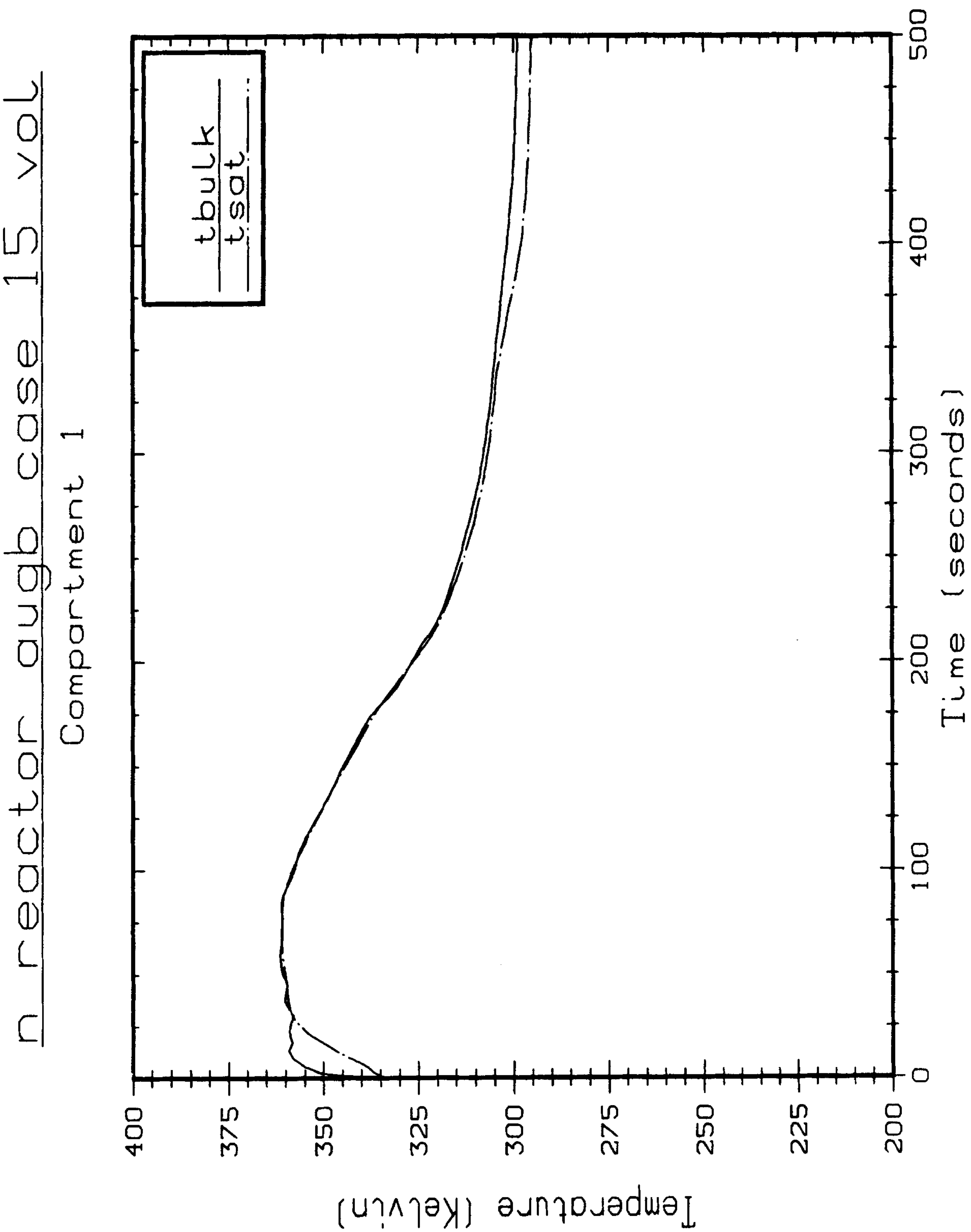

n reactor base case 15 vol
Junction 4
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000
Volumetric Flow Rate (m**3/sec)
-200
-100
0
100
200
300
400
500
600
700

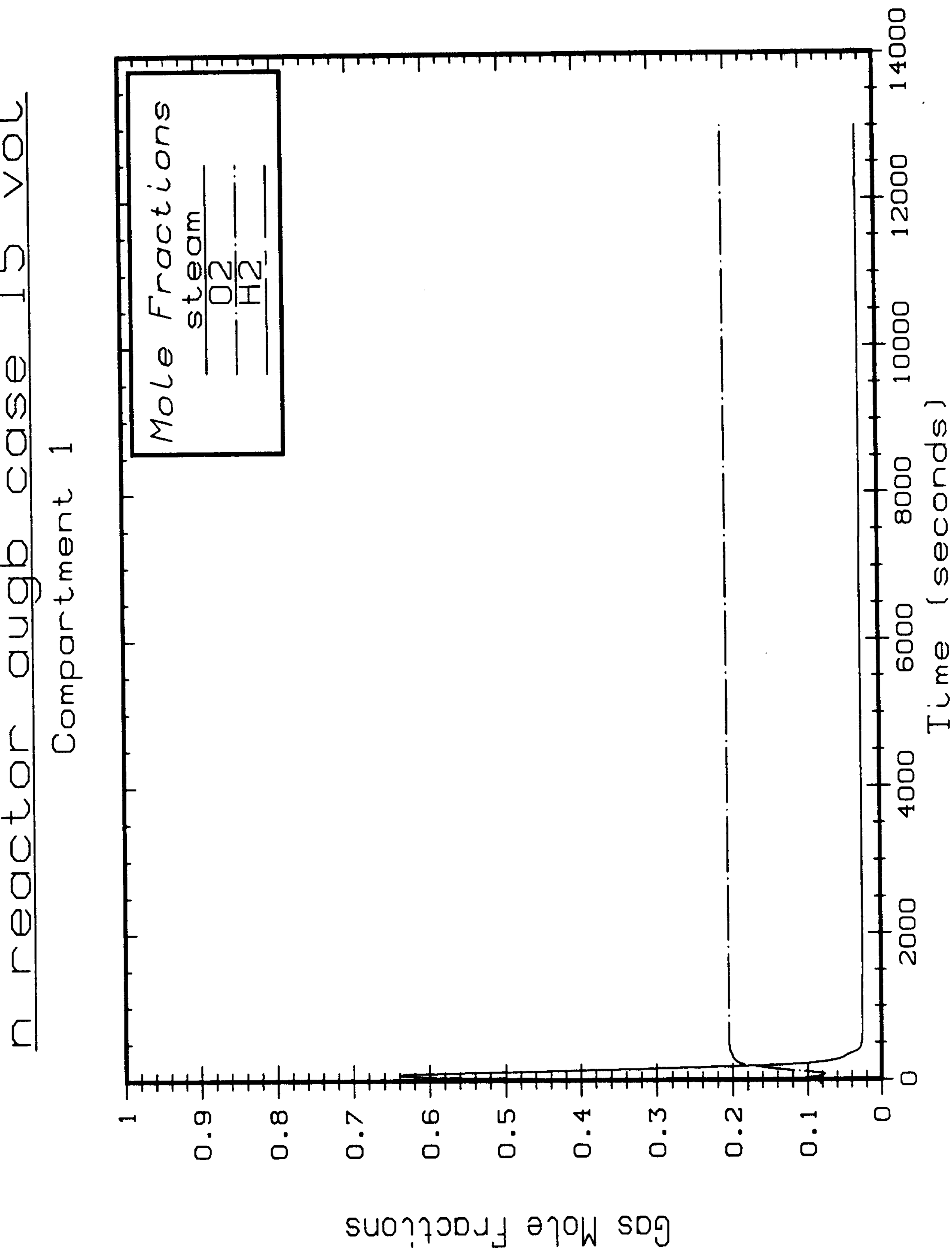

n reactor base case 15 vol
Leakage from Leak 1
Volumetric Leak Rate (m**3/s)
100
0
-100
-200
-300
-400
-500
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000

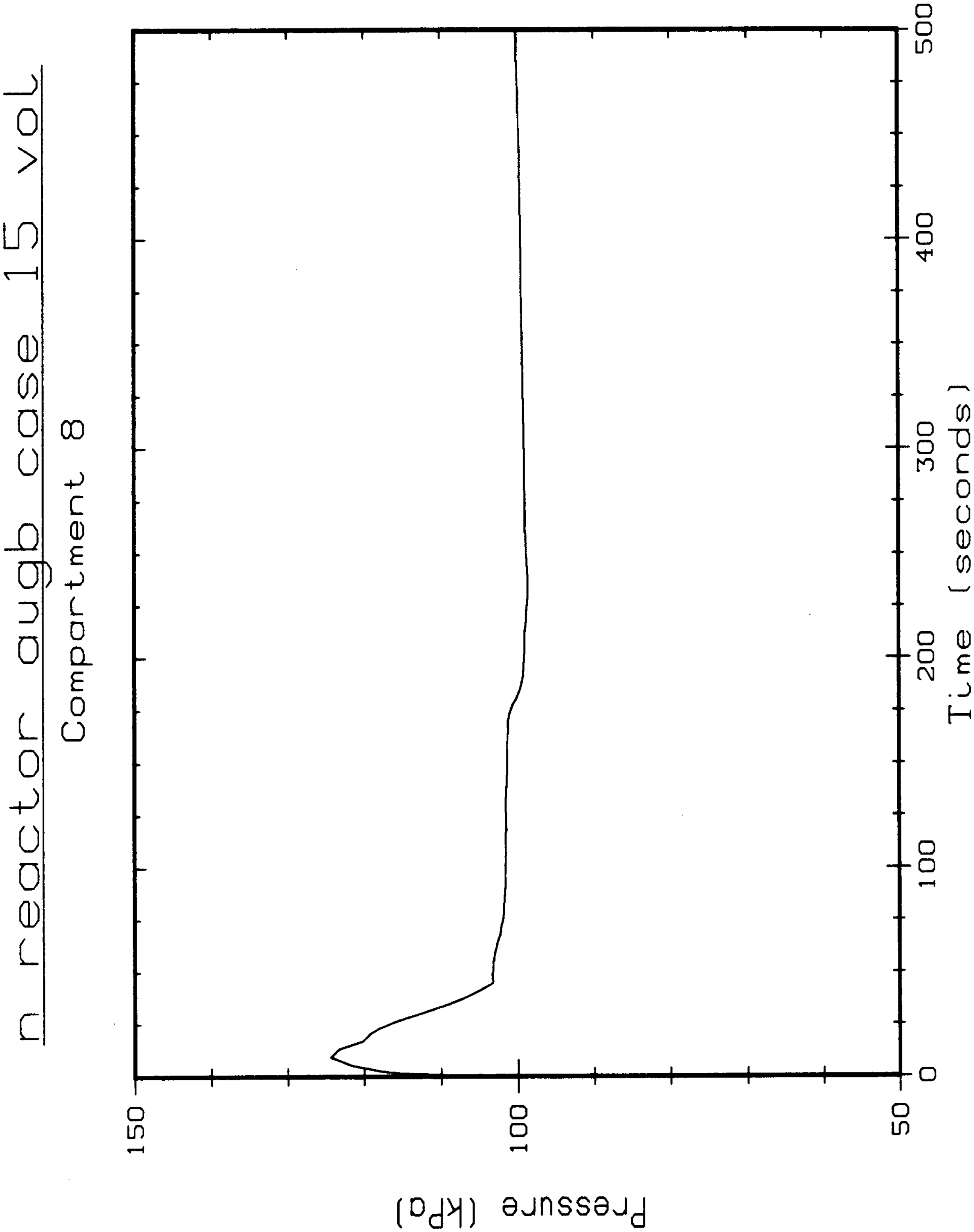
SELECTED PLOTS

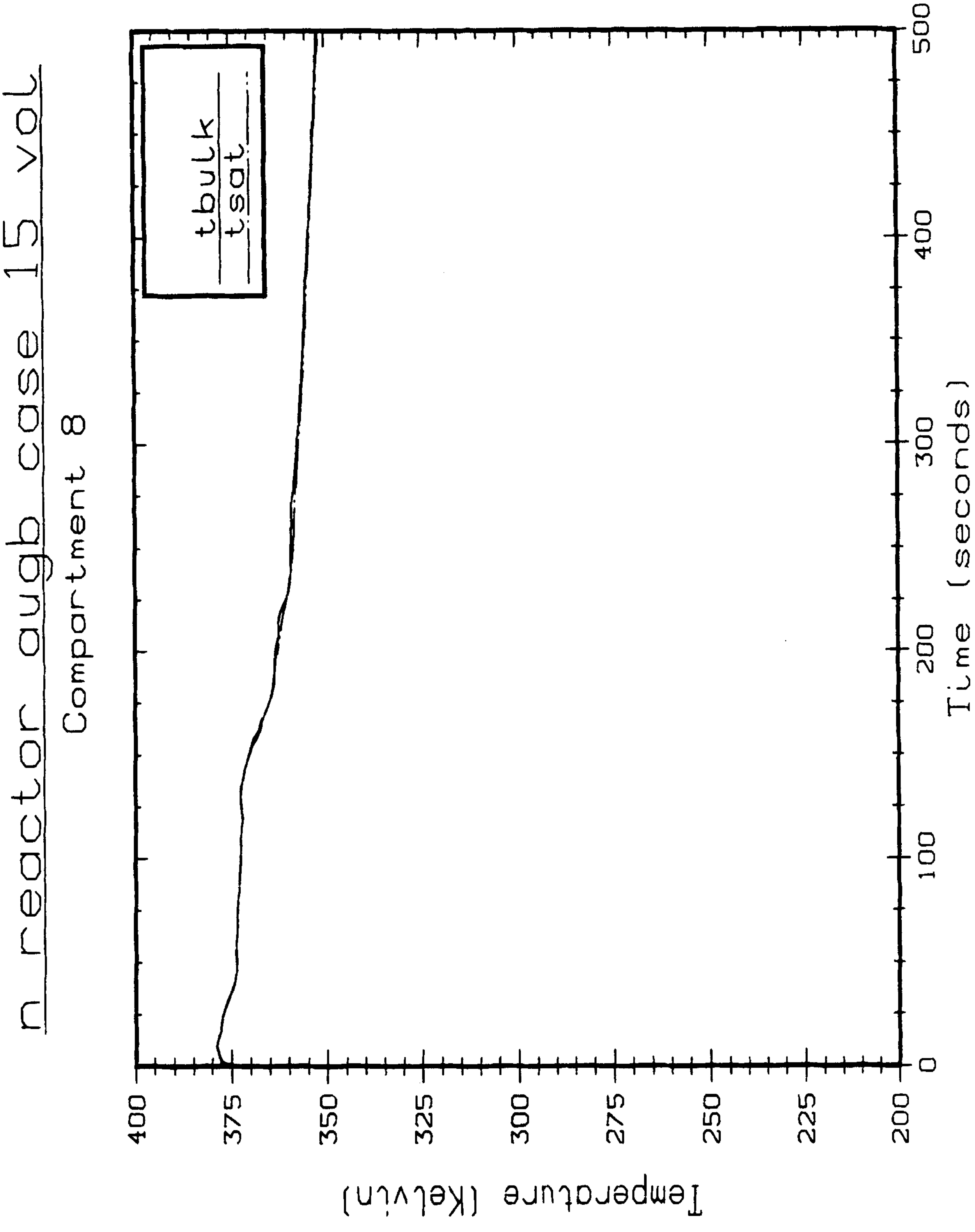
CASE 2

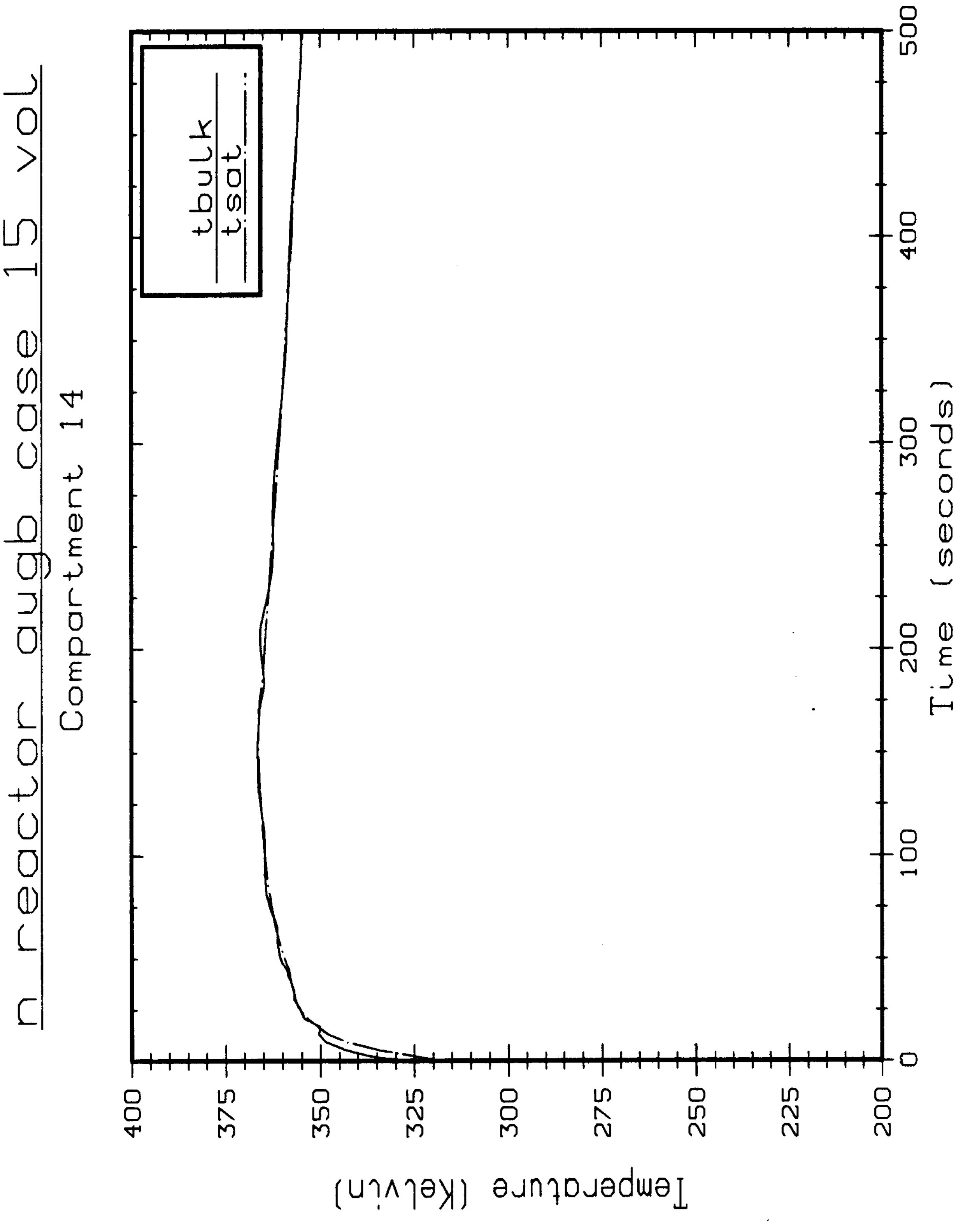

n reactor augb case 15 vol
Compartment 1
Pressure (kPa)
150
100
50
Time (seconds)
0
100
200
300
400
500


n reactor augb case 15 vol
Compartment 1
tbulk
tsat
Temperature (Kelvin)
400
375
350
325
300
275
250
225
200
Time (seconds)
0
100
200
300
400
500


n reactor augb case 15 vol
Compartment 1
Mole Fractions
steam
O2
H2
Gas Mole Fractions
Time (seconds)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
2000
4000
6000
8000
10000
12000
14000

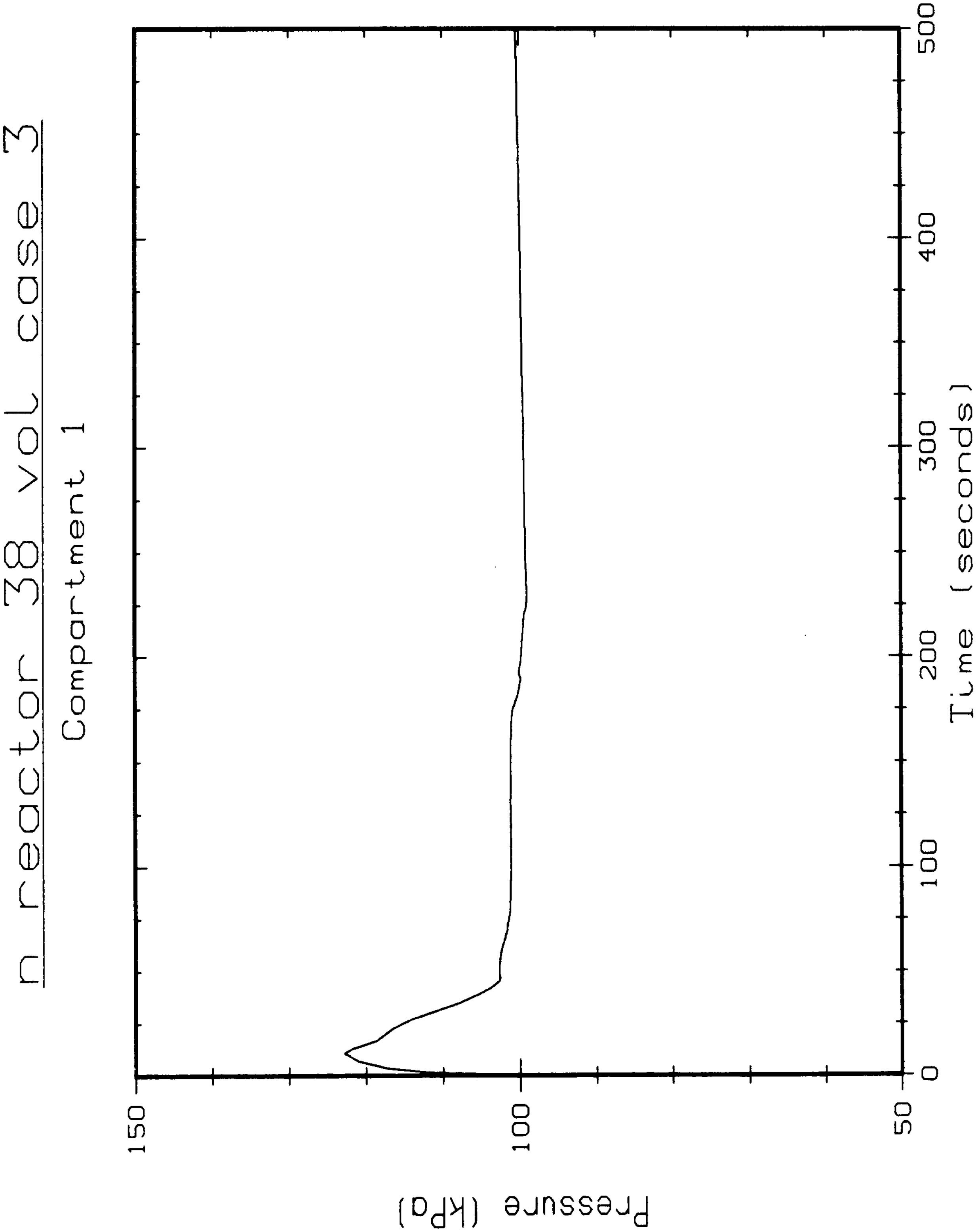

n reactor augb case 15 vol
Compartment 8
Pressure (kPa)
150
100
50
Time (seconds)
0
100
200
300
400
500

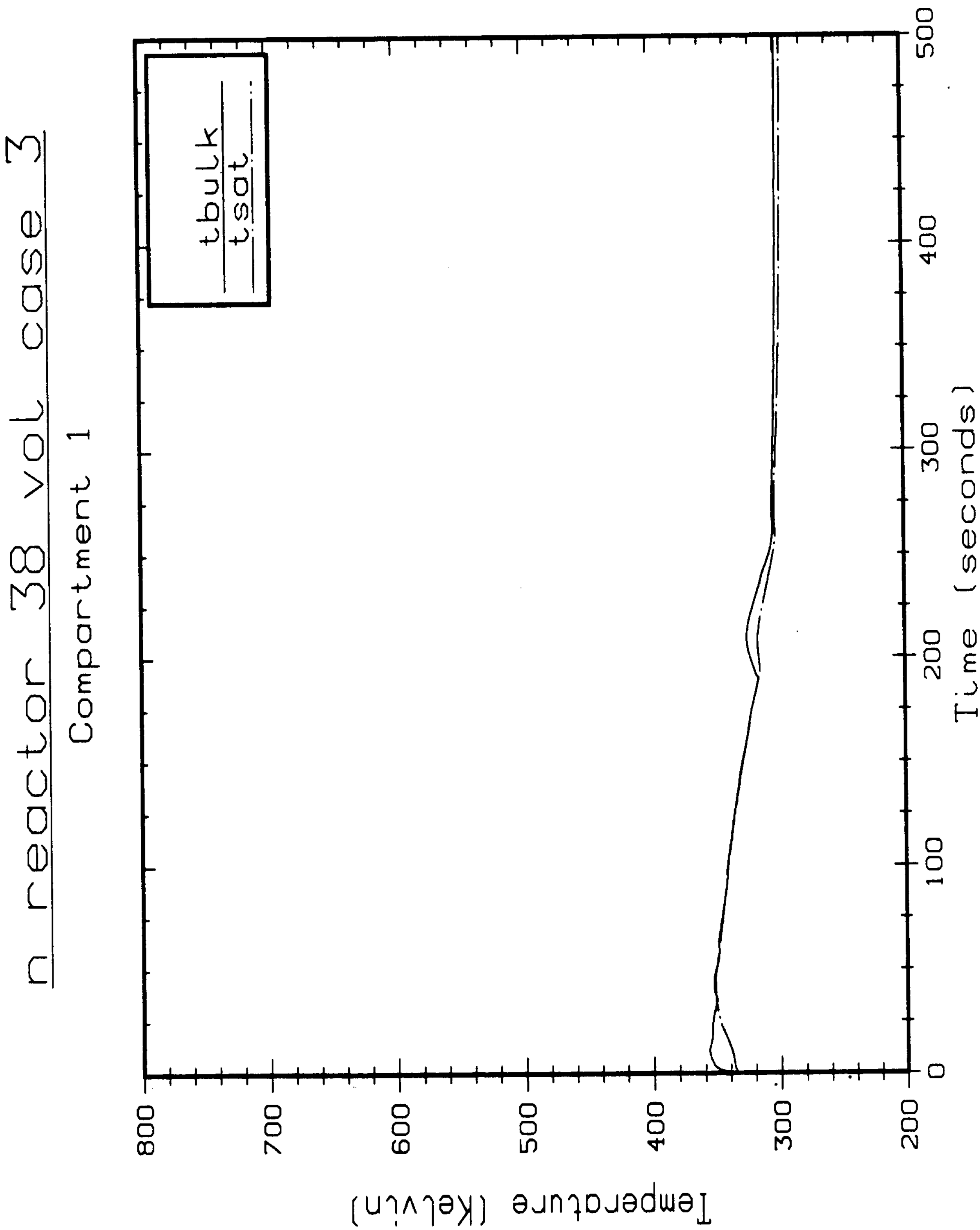

n reactor augb case 15 vol
Compartment 8
tbulk
tsat
Time (seconds)
Temperature (Kelvin)
0
100
200
300
400
500
200
225
250
275
300
325
350
375
400

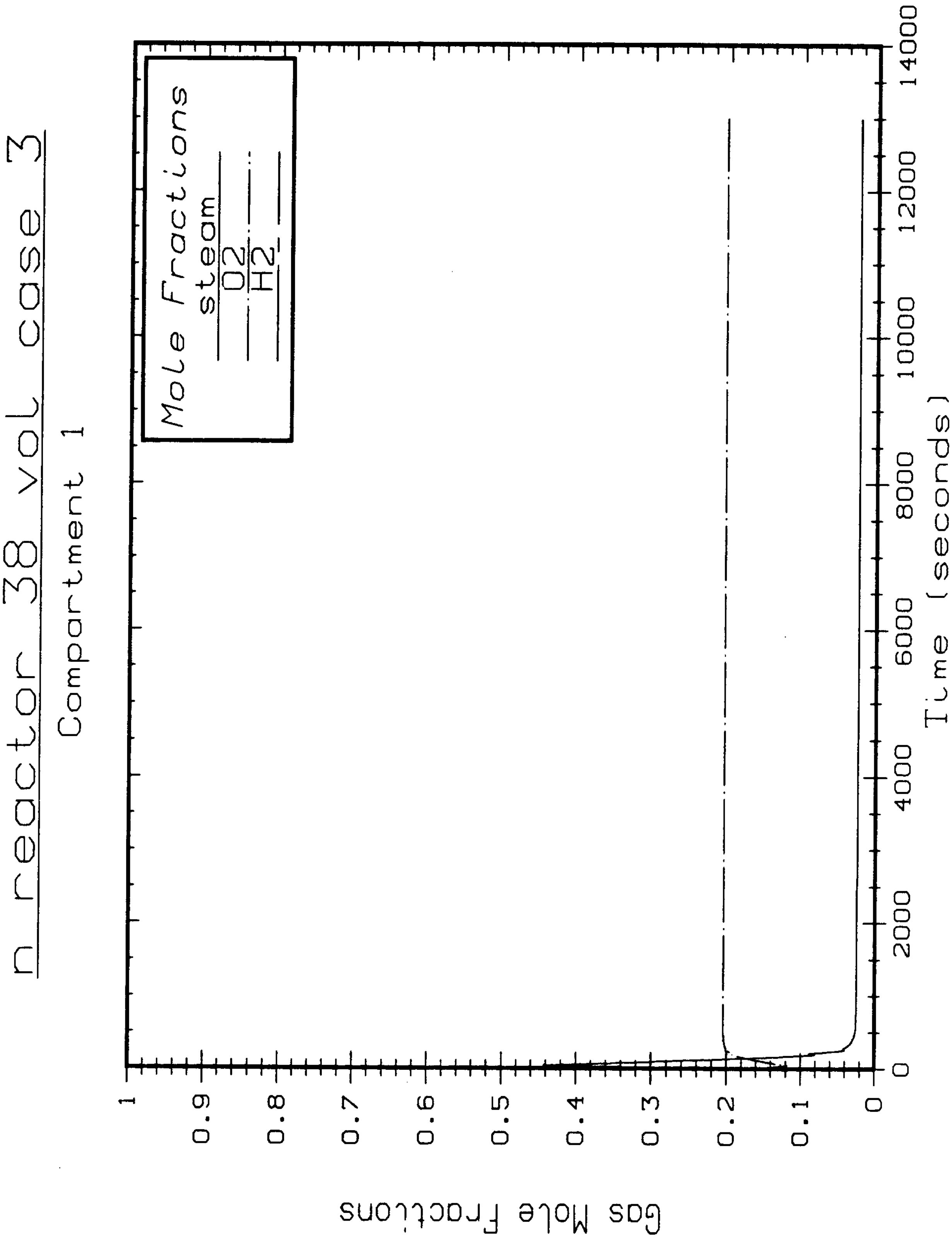

n reactor augb case 15 vol
Compartment 14
tbulk
tsat
Temperature (Kelvin)
400
375
350
325
300
275
250
225
200
Time (seconds)
0
100
200
300
400
500

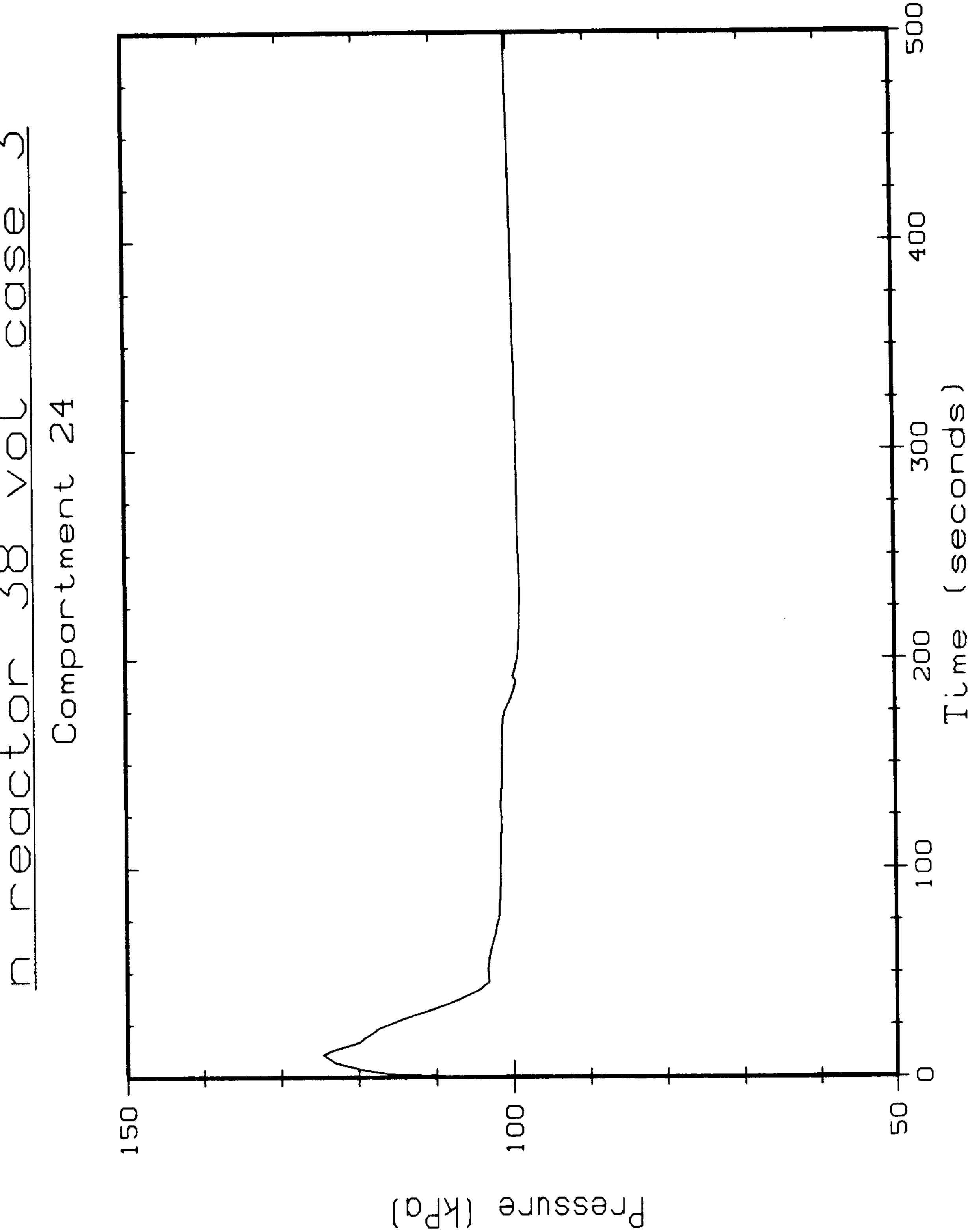
SELECTED PLOTS

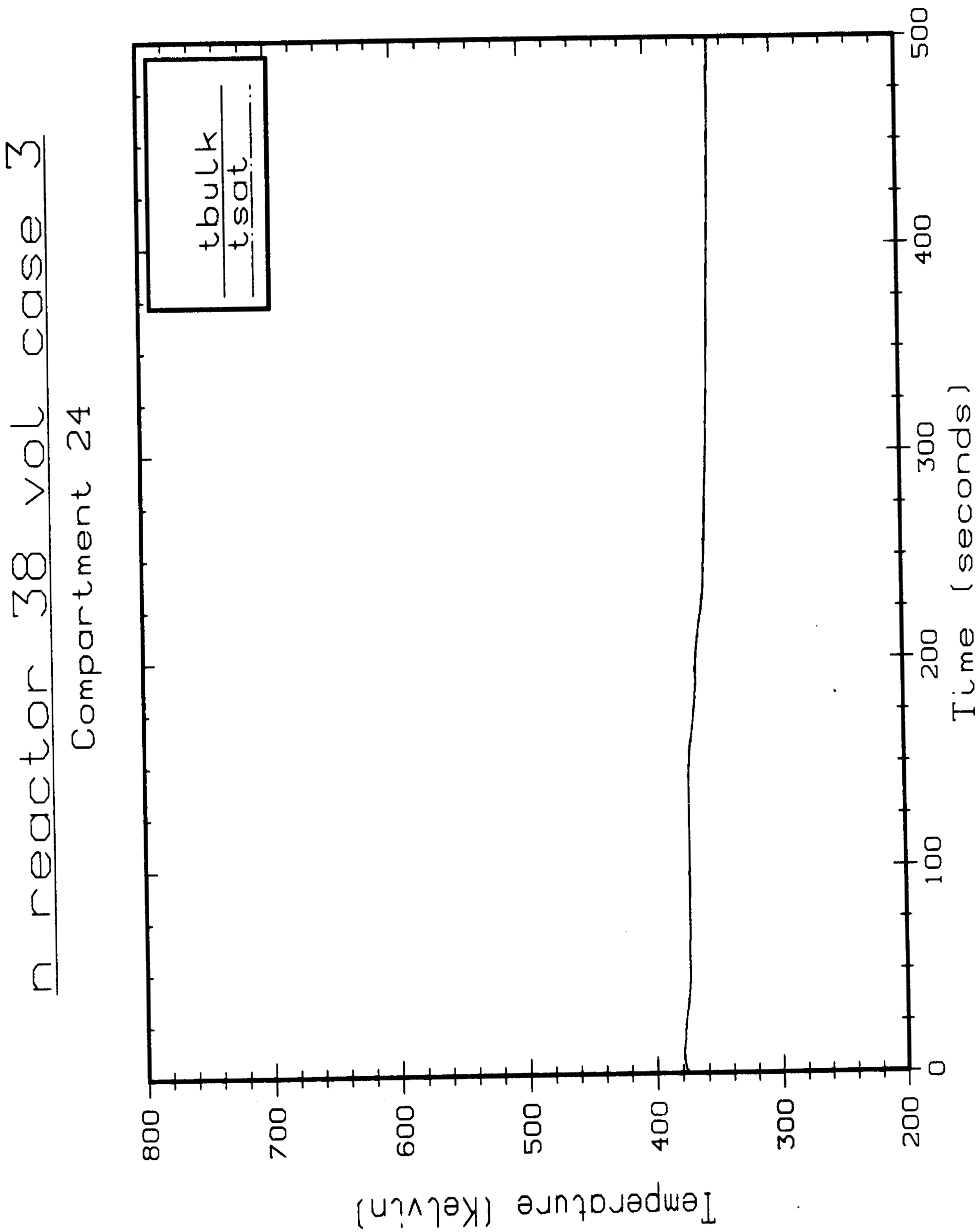
CASE 3

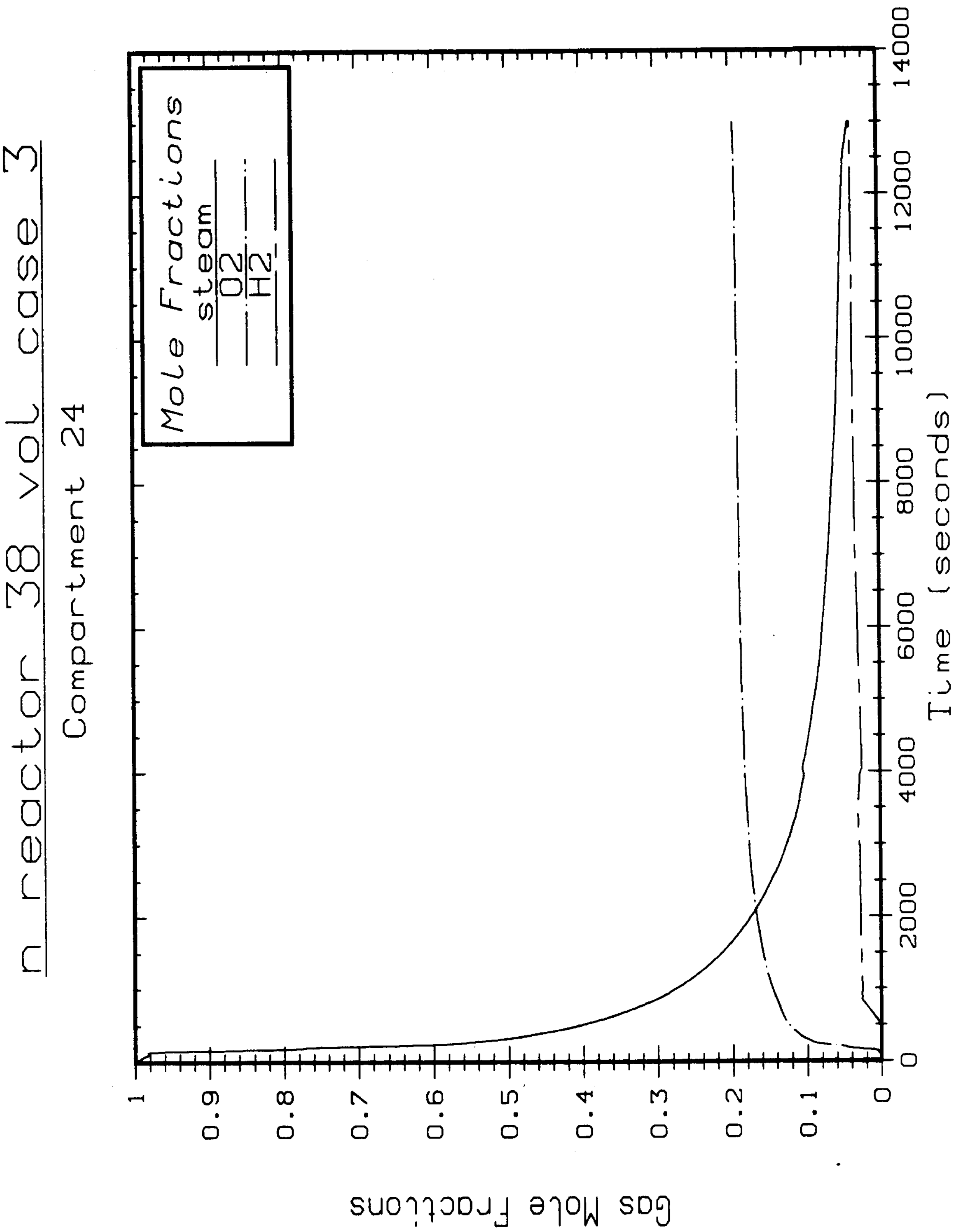

n reactor 38 vol case 3
Compartment 1
Pressure (kPa)
150
100
50
Time (seconds)
0
100
200
300
400
500

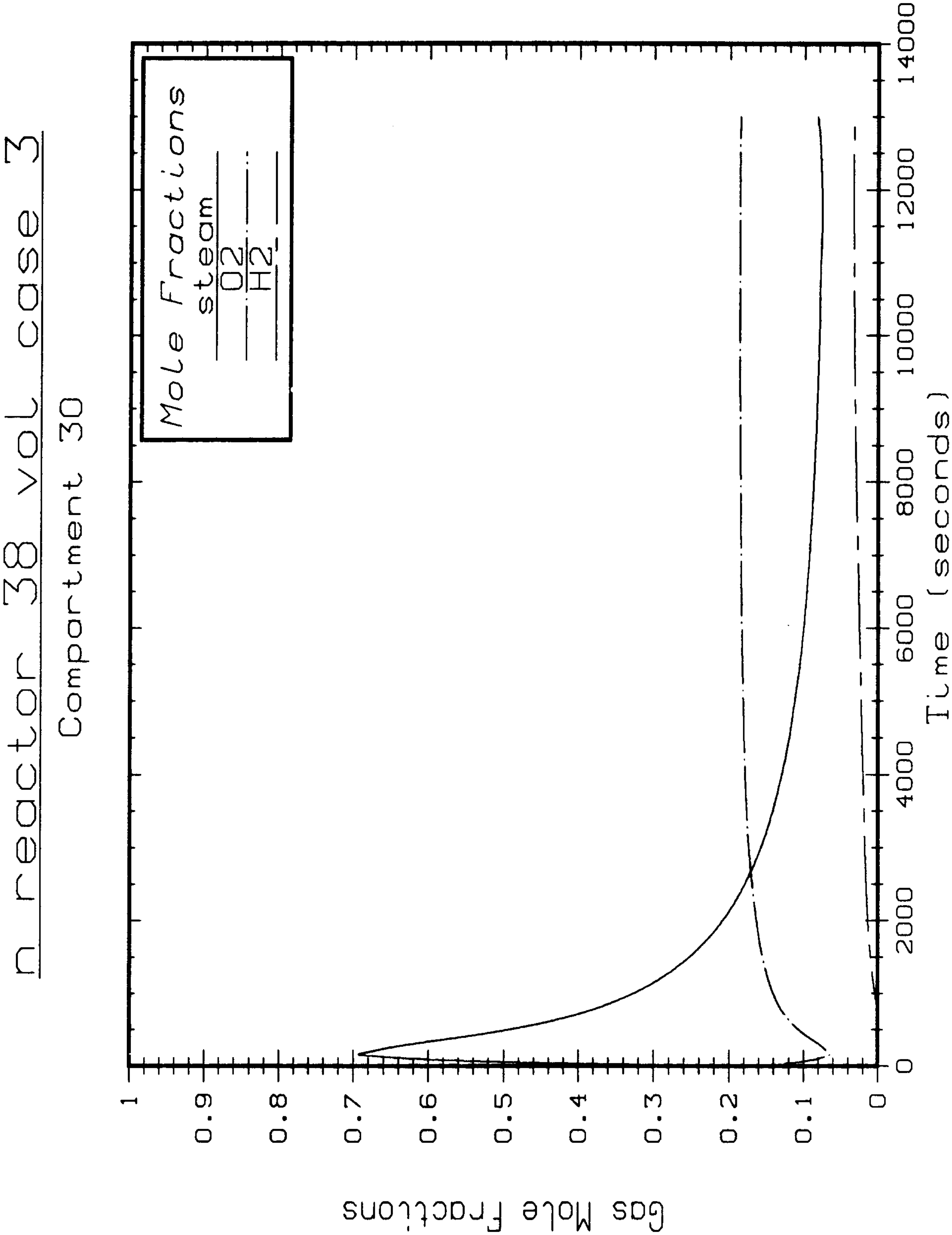

n reactor 38 vol case 3
Compartment 1
tbulk
tsat
Temperature (Kelvin)
800
700
600
500
400
300
200
Time (seconds)
0
100
200
300
400
500

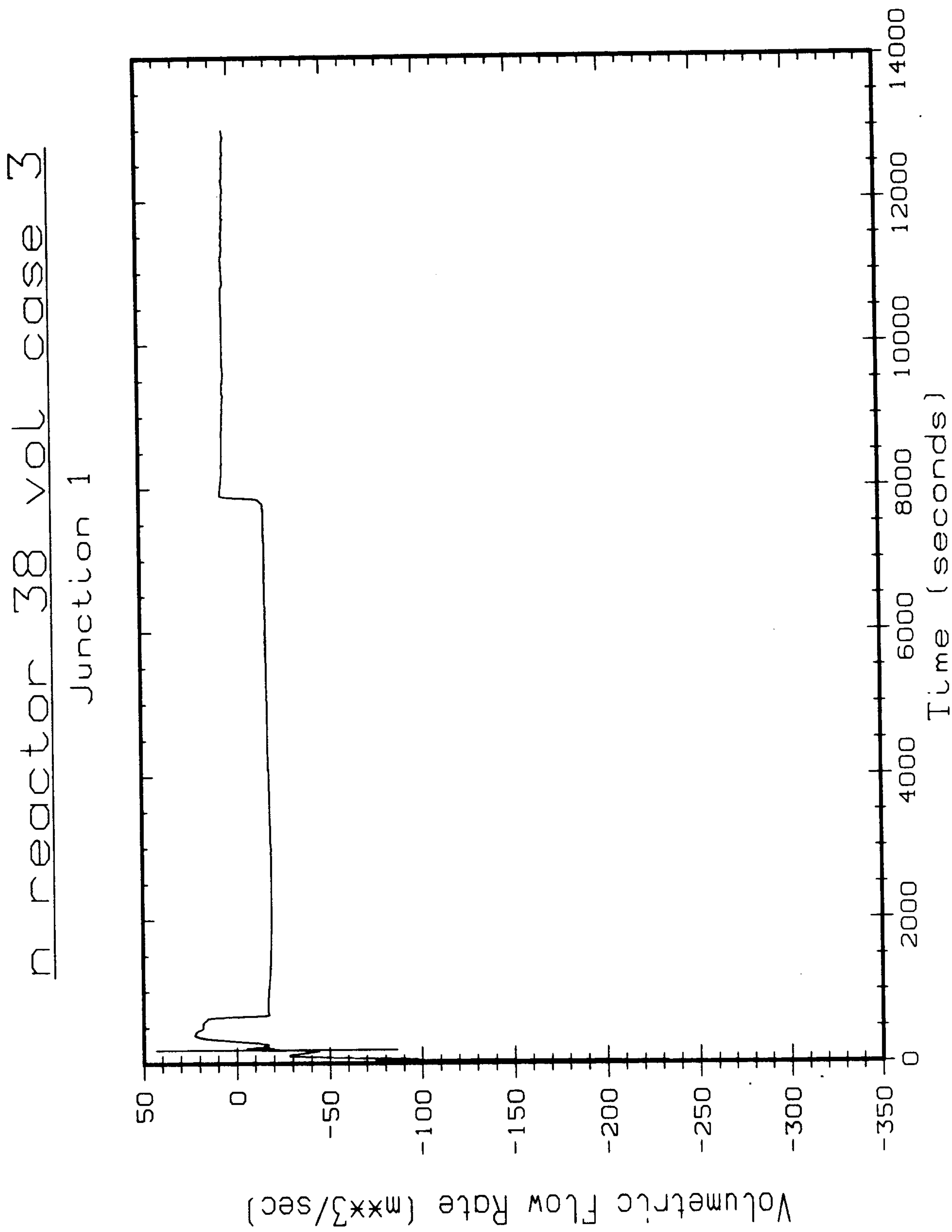

n reactor 38 vol case 3
Compartment 1
Mole Fractions
steam
O2
H2
Gas Mole Fractions
Time (seconds)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
2000
4000
6000
8000
10000
12000
14000

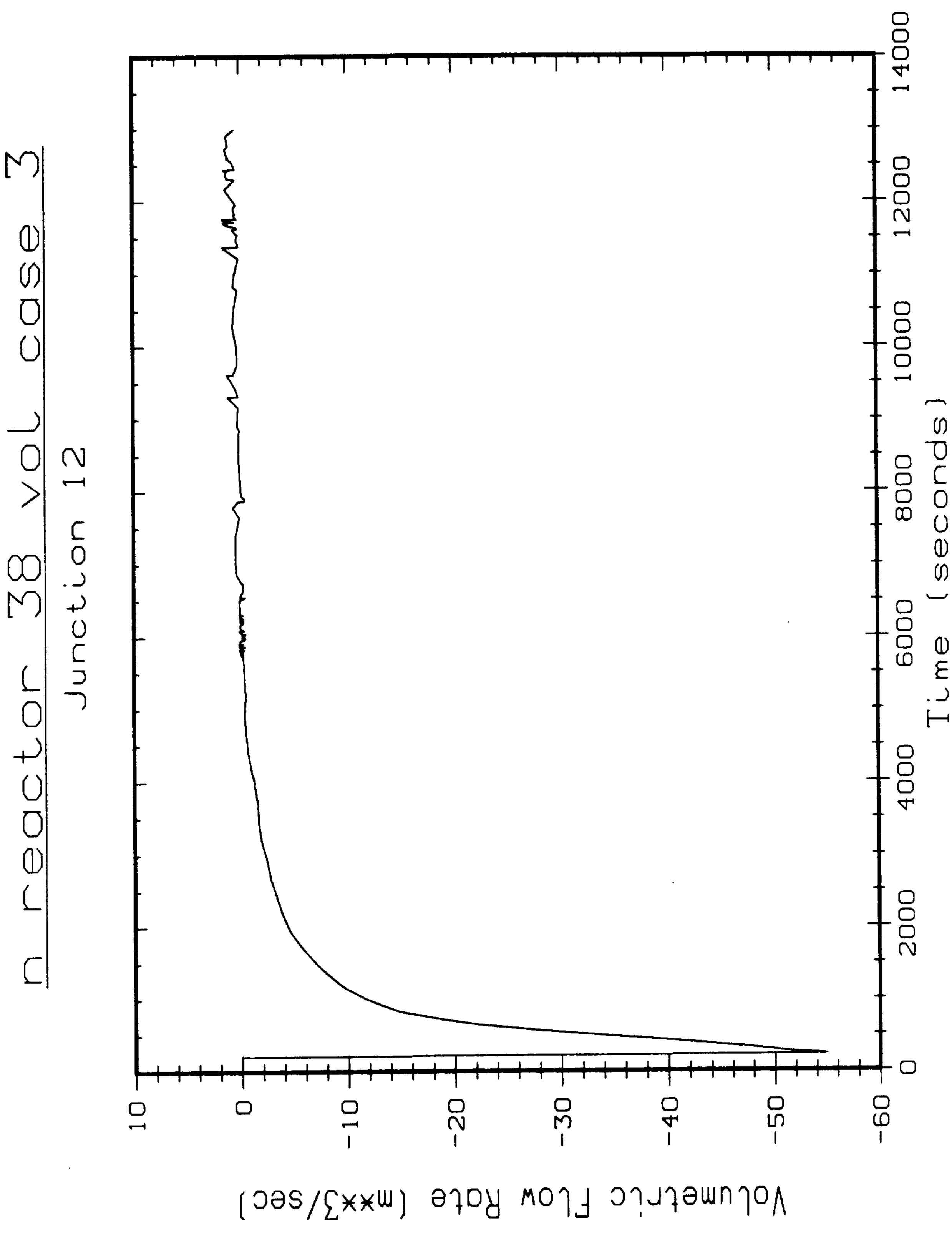

n reactor 38 vol case 3
Compartment 24
Pressure (kPa)
150
100
50
Time (seconds)
0
100
200
300
400
500

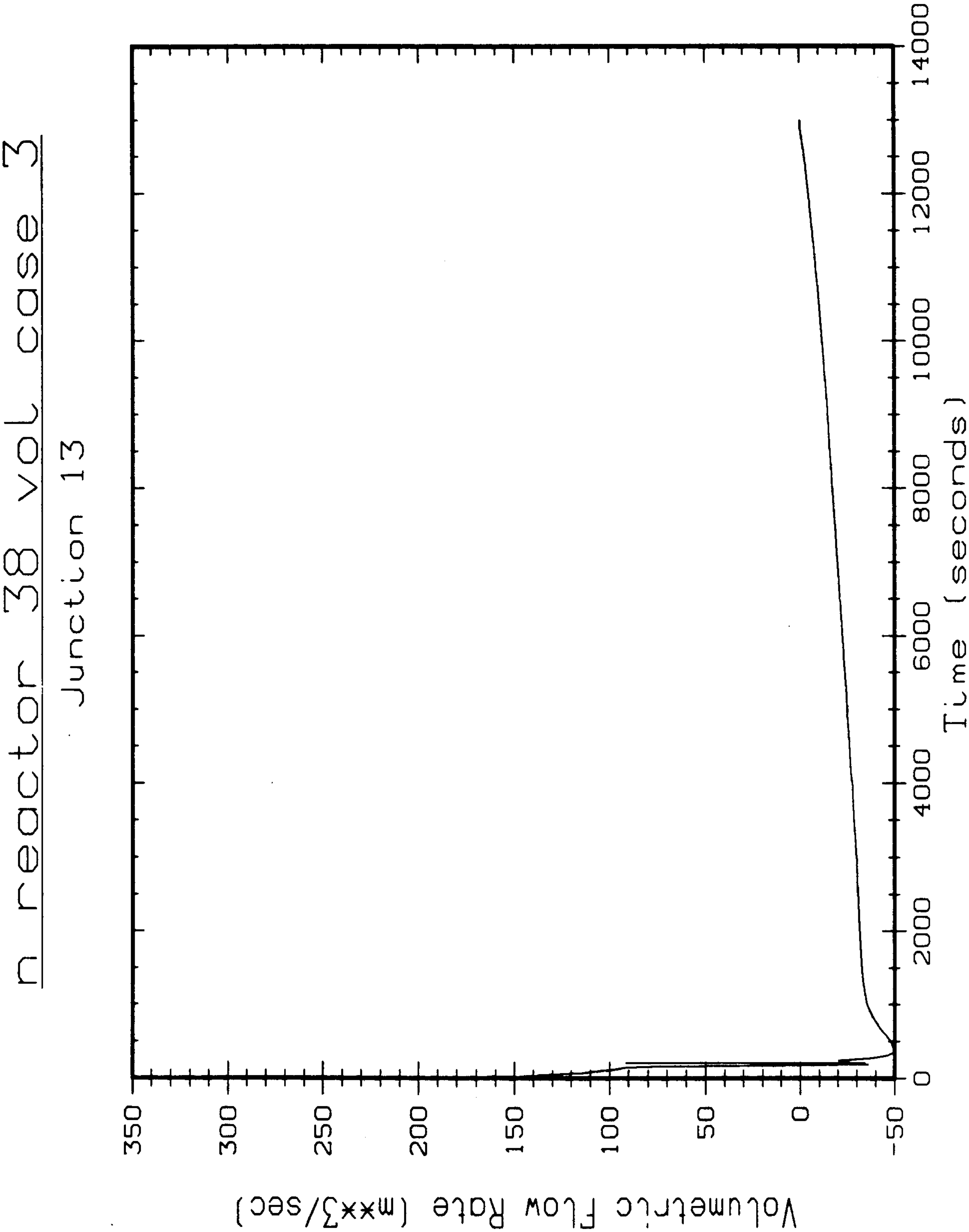

n reactor 38 vol case 3
Compartment 24
tbulk
tsat
Time (seconds)
0
100
200
300
400
500
Temperature (Kelvin)
200
300
400
500
600
700
800

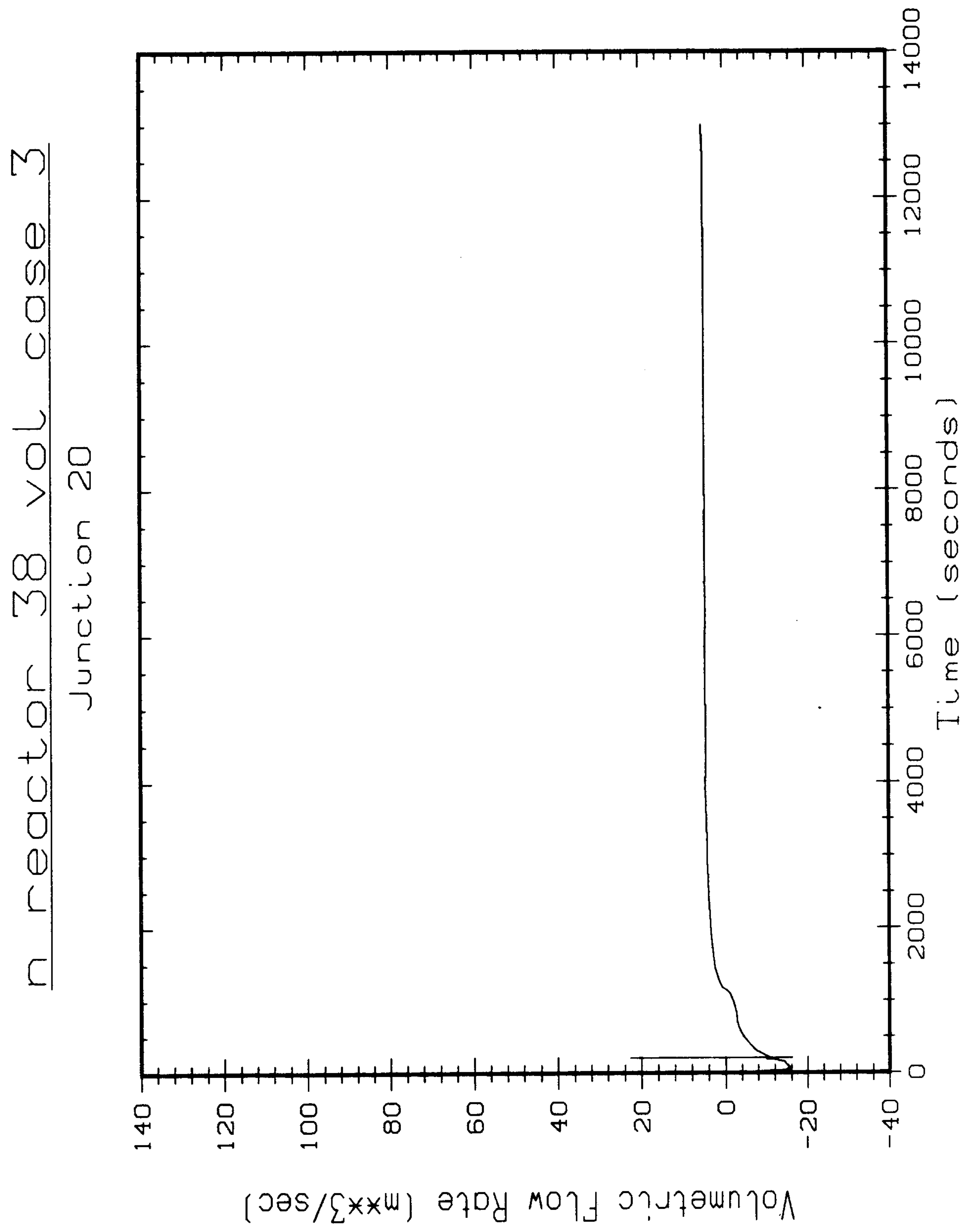

n reactor 38 vol case 3
Compartment 24
Mole Fractions
steam
O2
H2
Time (seconds)
Gas Mole Fractions
0
2000
4000
6000
8000
10000
12000
14000
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


n reactor 38 vol case 3
Compartment 30
Mole Fractions
steam
O2
H2
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000
Gas Mole Fractions
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


n reactor 38 vol case 3
Junction 1
Volumetric Flow Rate (m**3/sec)
50
0
-50
-100
-150
-200
-250
-300
-350
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000

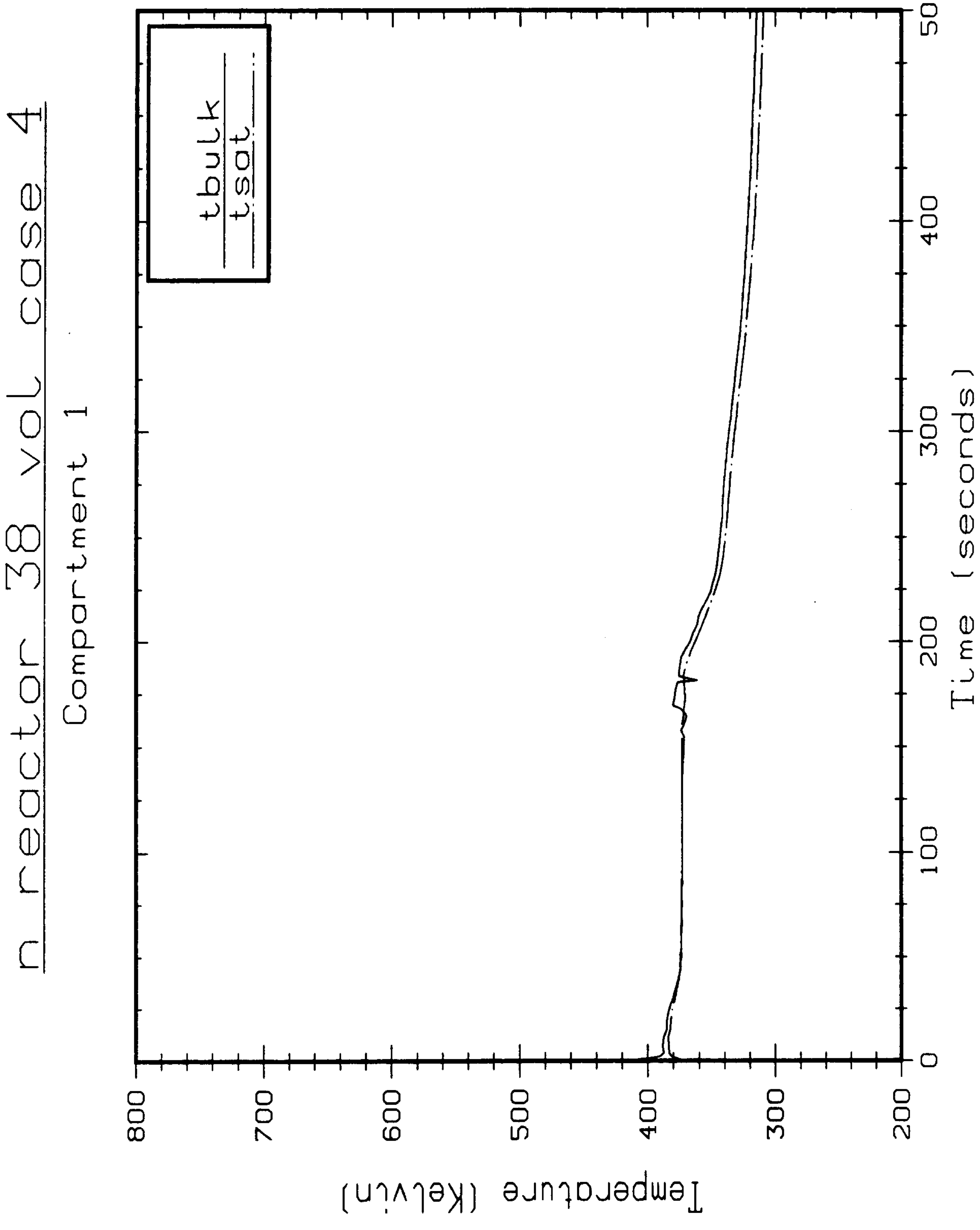

n reactor 38 vol case 3
Junction 12
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000
Volumetric Flow Rate (m**3/sec)
10
0
-10
-20
-30
-40
-50
-60

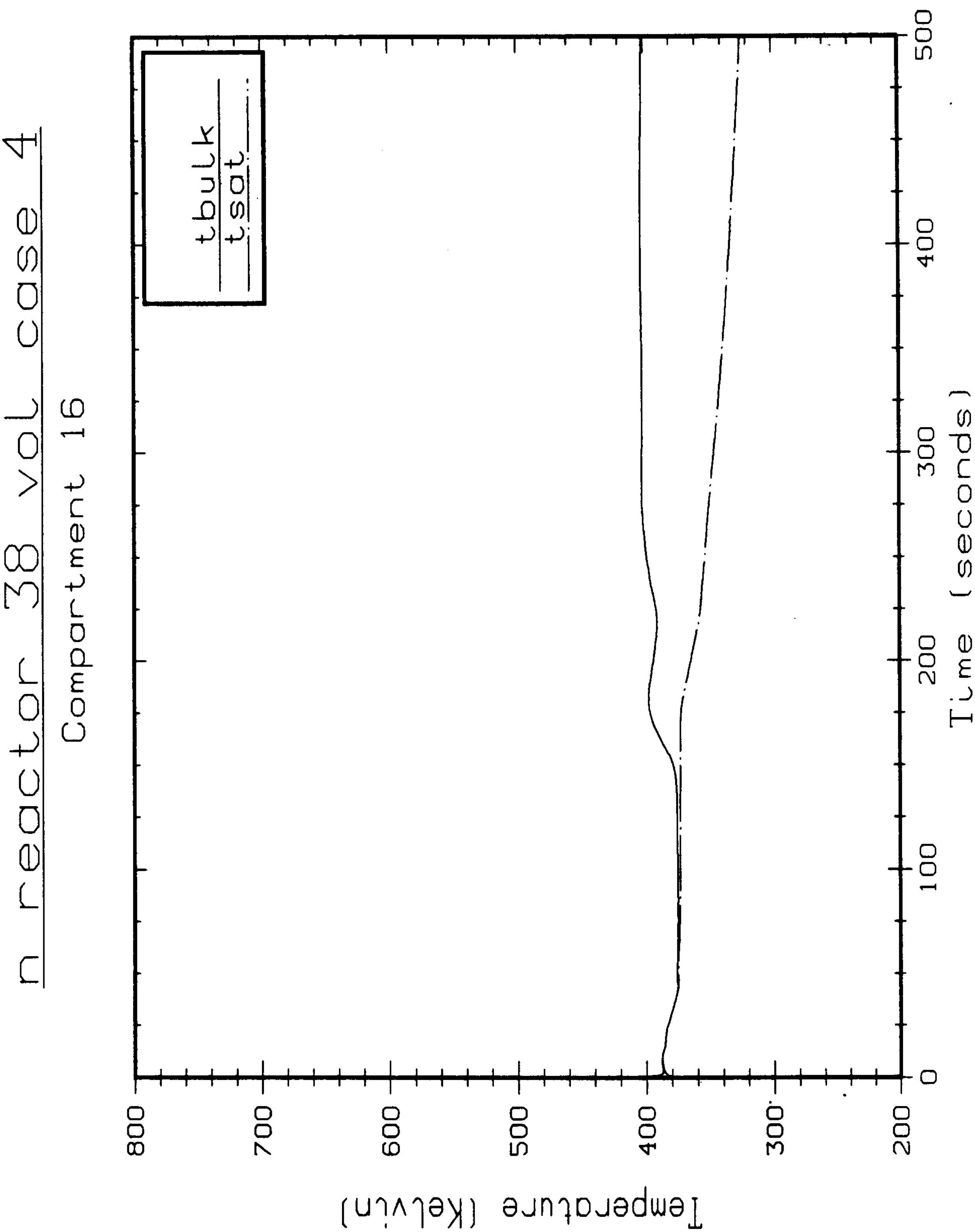

n reactor 38 vol case 3
Junction 13
Volumetric Flow Rate (m**3/sec)
350
300
250
200
150
100
50
0
-50
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000

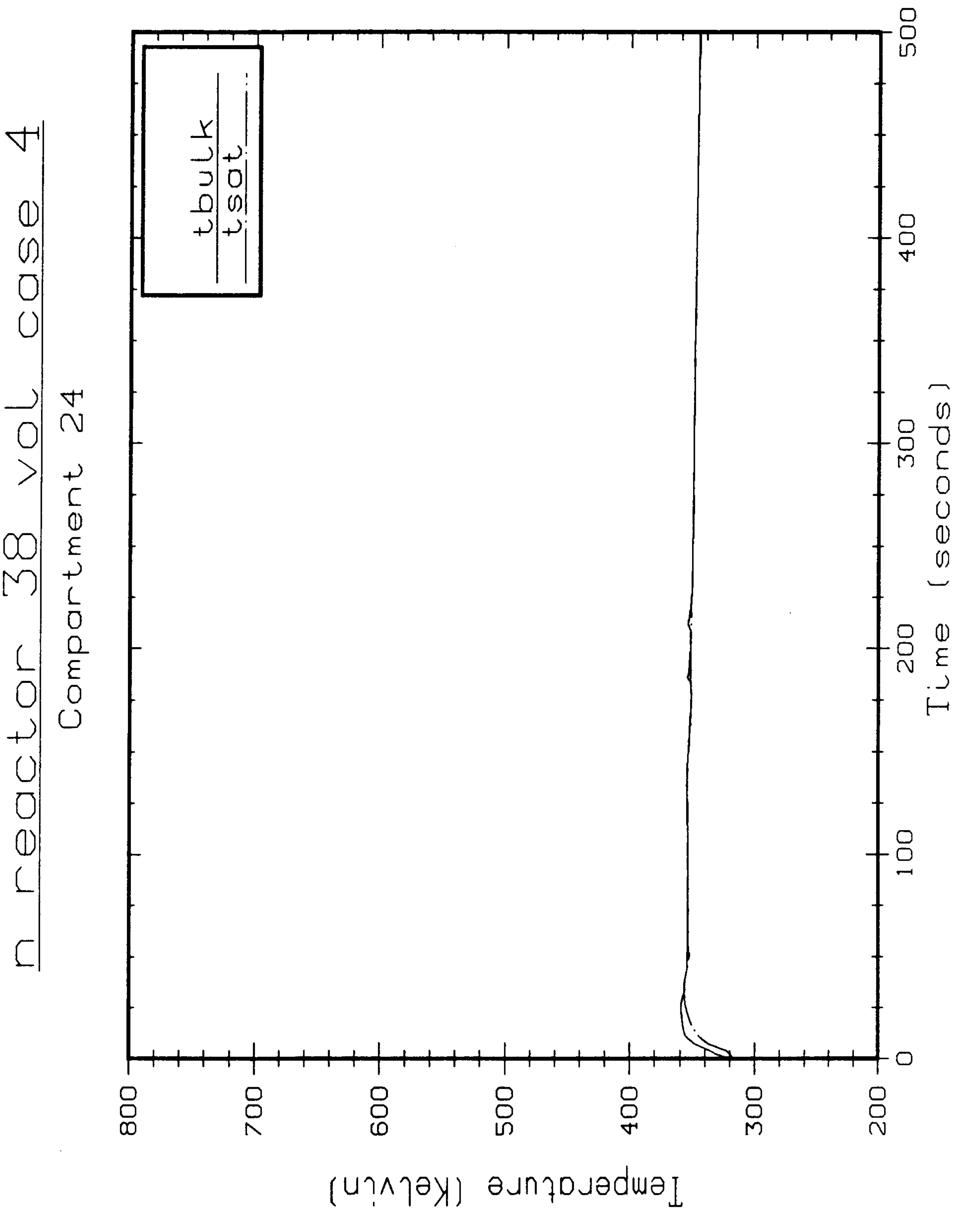

n reactor 38 vol case 3
Junction 20
Volumetric Flow Rate (m**3/sec)
Time (seconds)
140
120
100
80
60
40
20
0
-20
-40
0
2000
4000
6000
8000
10000
12000
14000

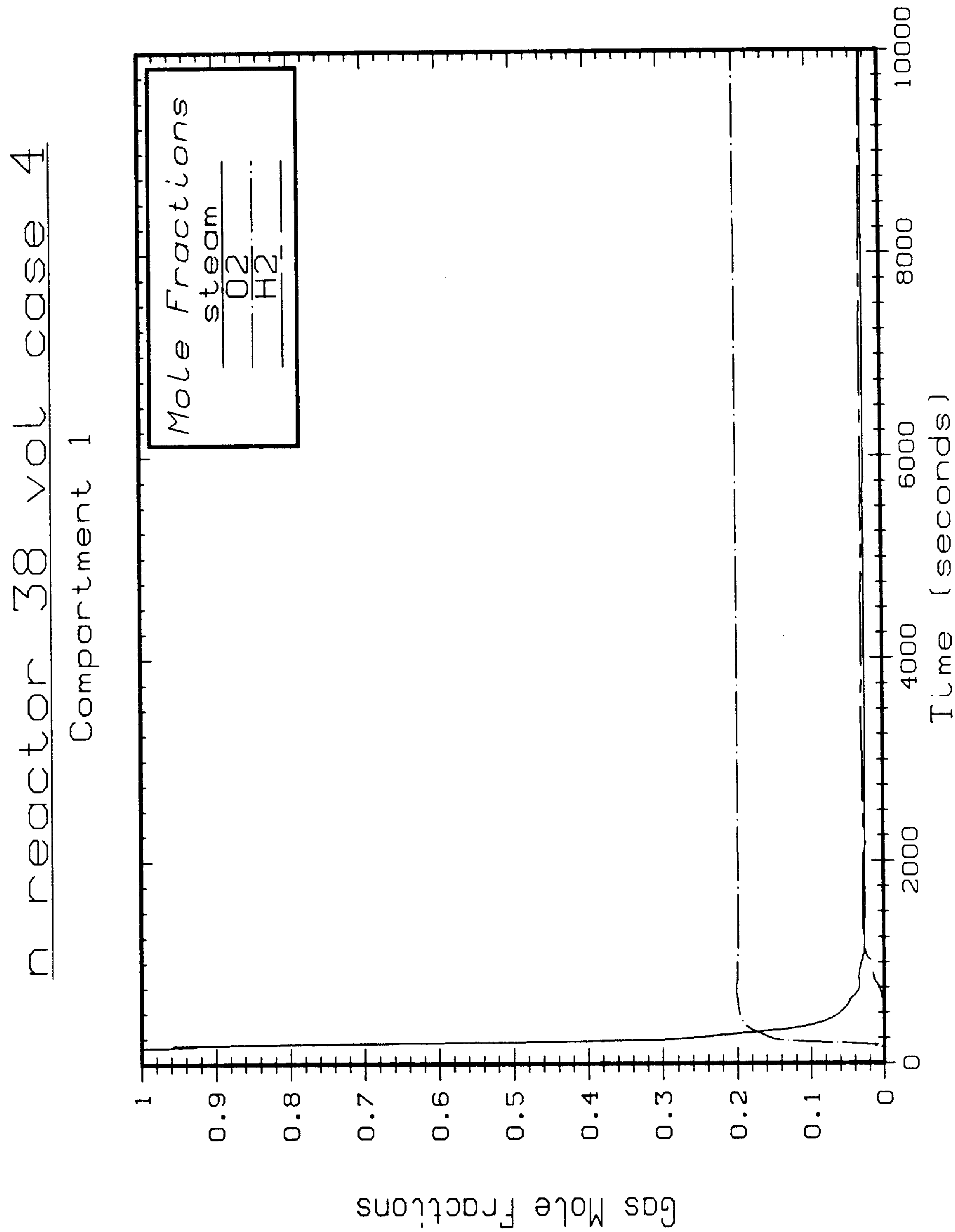
SELECTED PLOTS

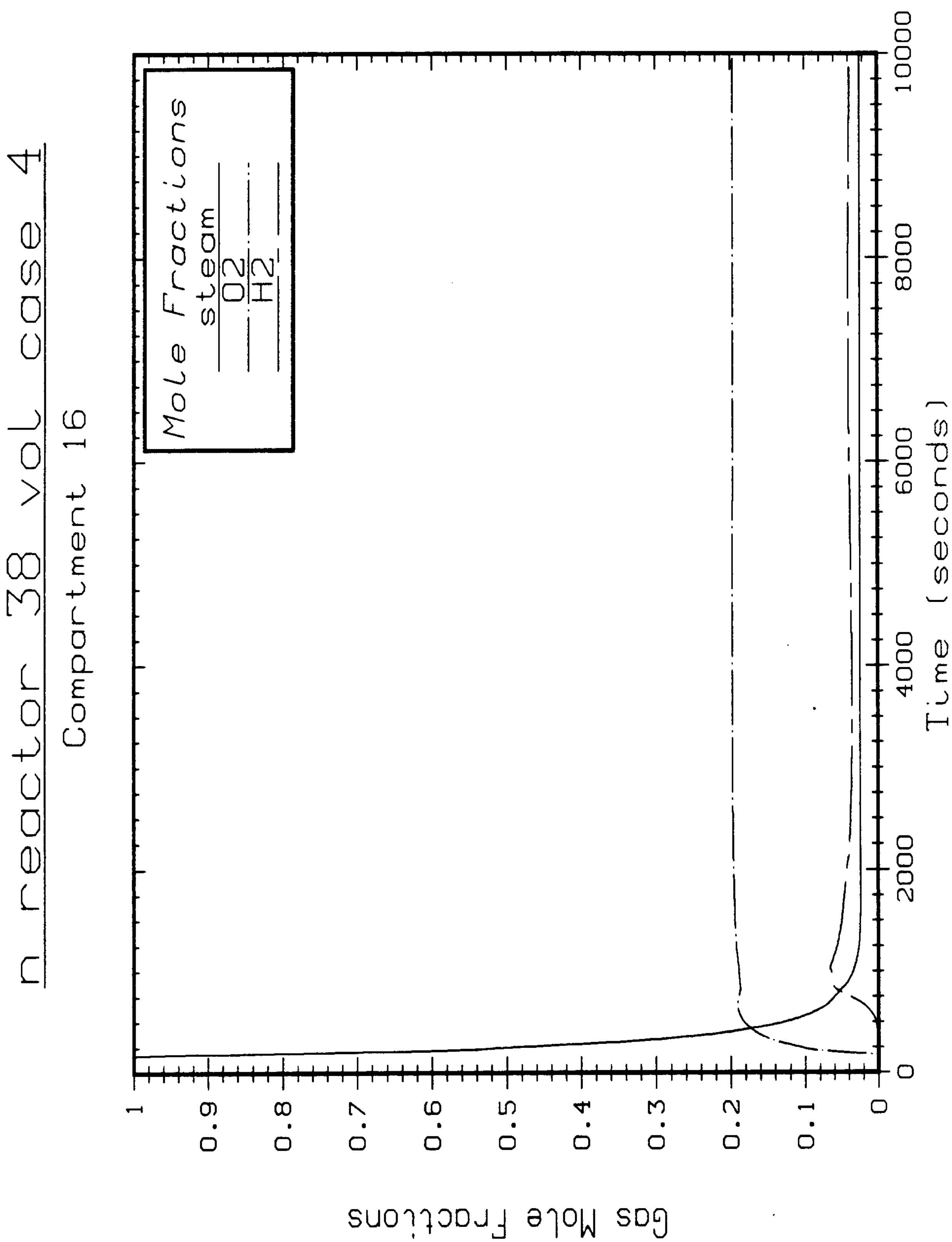
CASE 4N

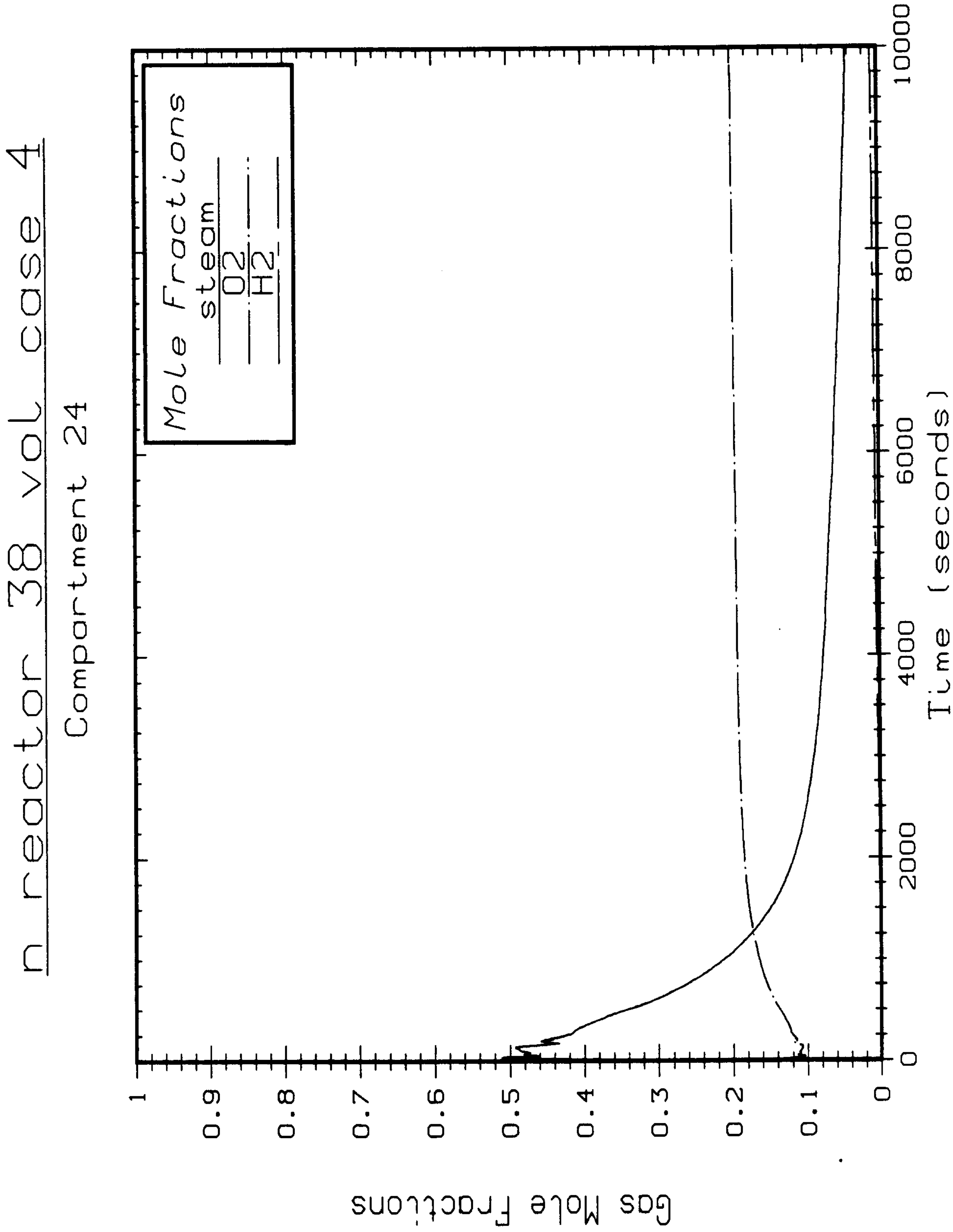

n reactor 38 vol case 4
Compartment 1
tbulk
tsat
Temperature (Kelvin)
800
700
600
500
400
300
200
Time (seconds)
0
100
200
300
400
500

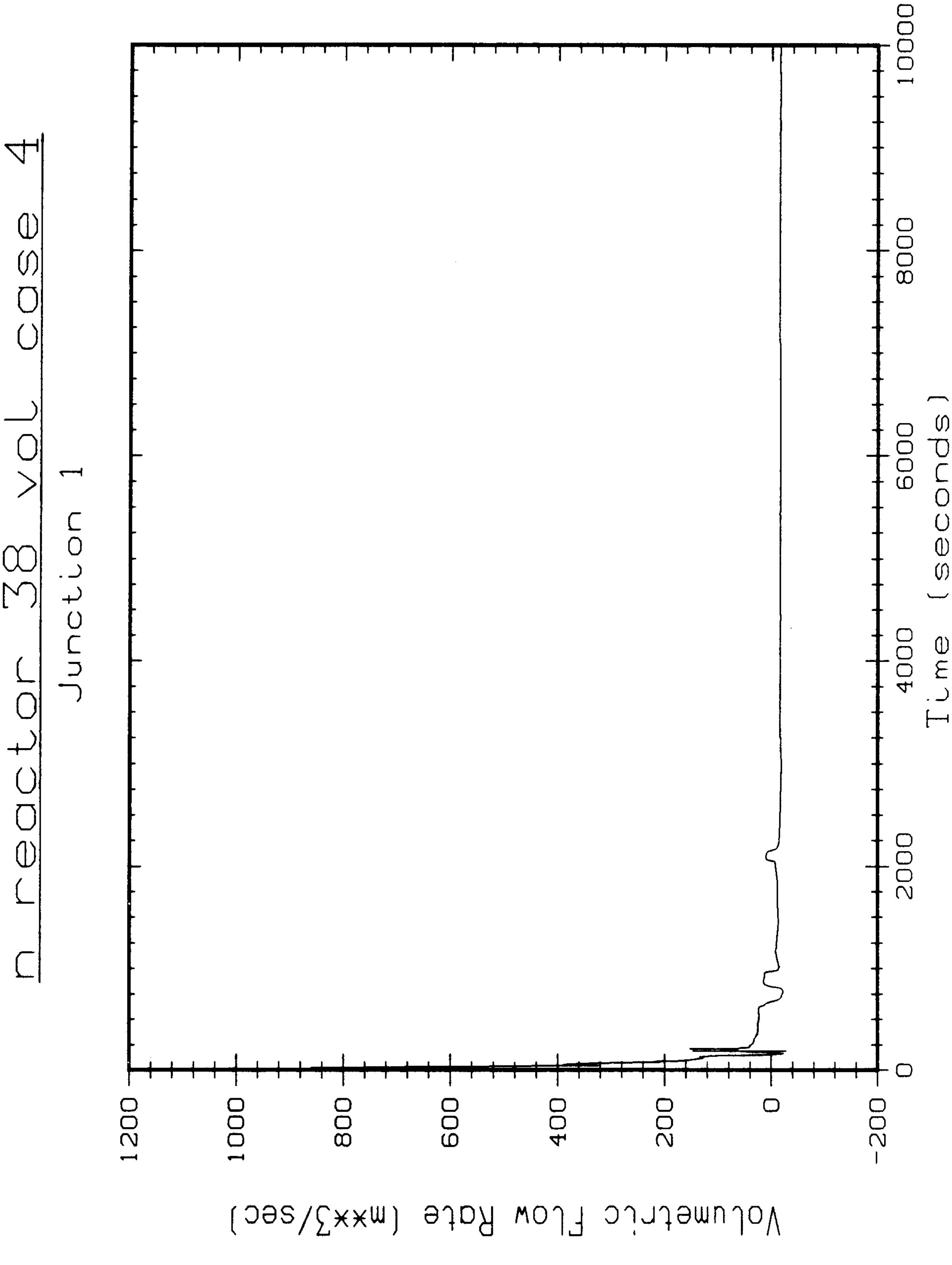

n reactor 38 vol case 4
Compartment 16
tbulk
tsat
Time (seconds)
Temperature (Kelvin)
0
100
200
300
400
500
200
300
400
500
600
700
800

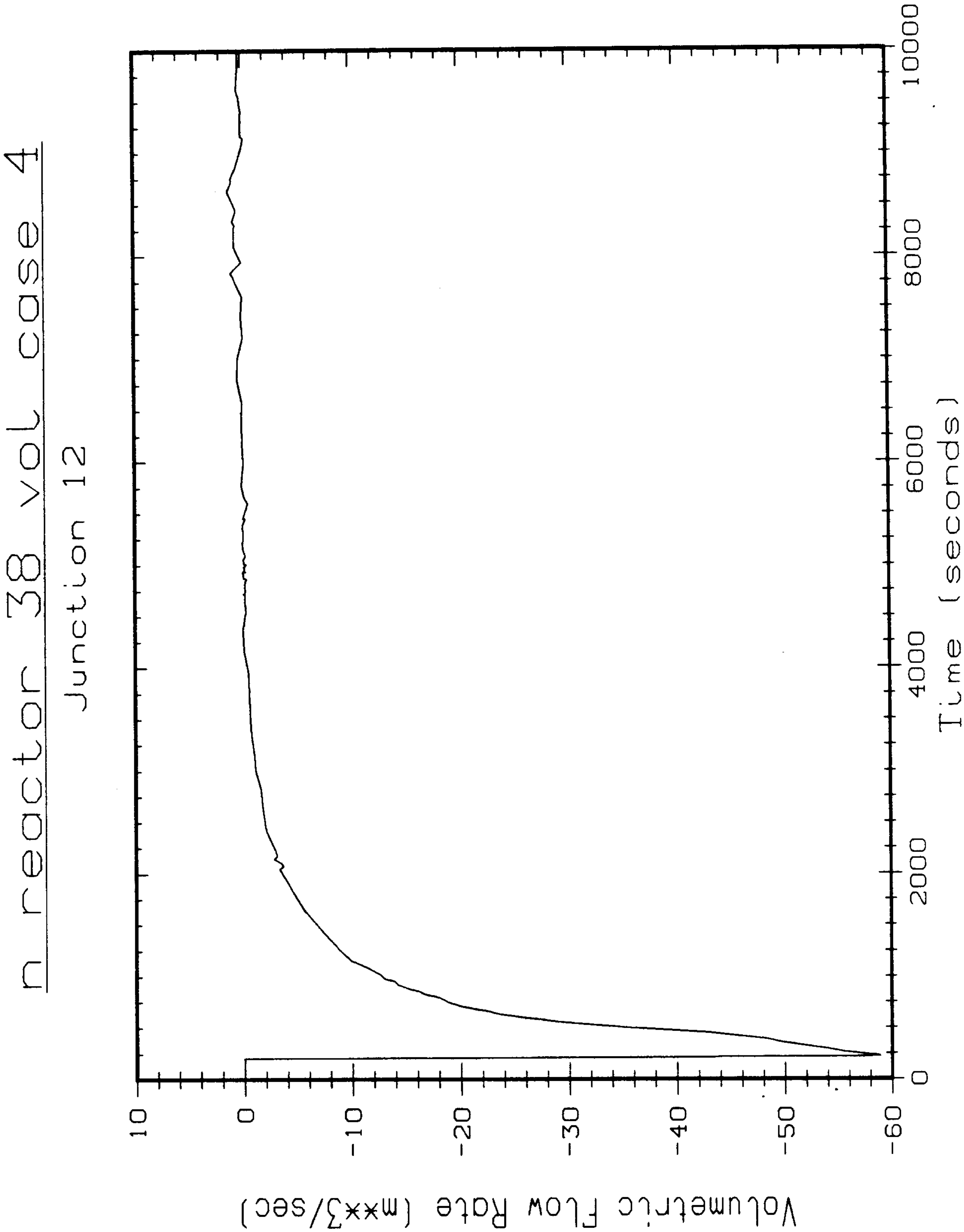

n reactor 38 vol case 4
Compartment 24
tbulk
tsat
Temperature (Kelvin)
Time (seconds)
800
700
600
500
400
300
200
0
100
200
300
400
500

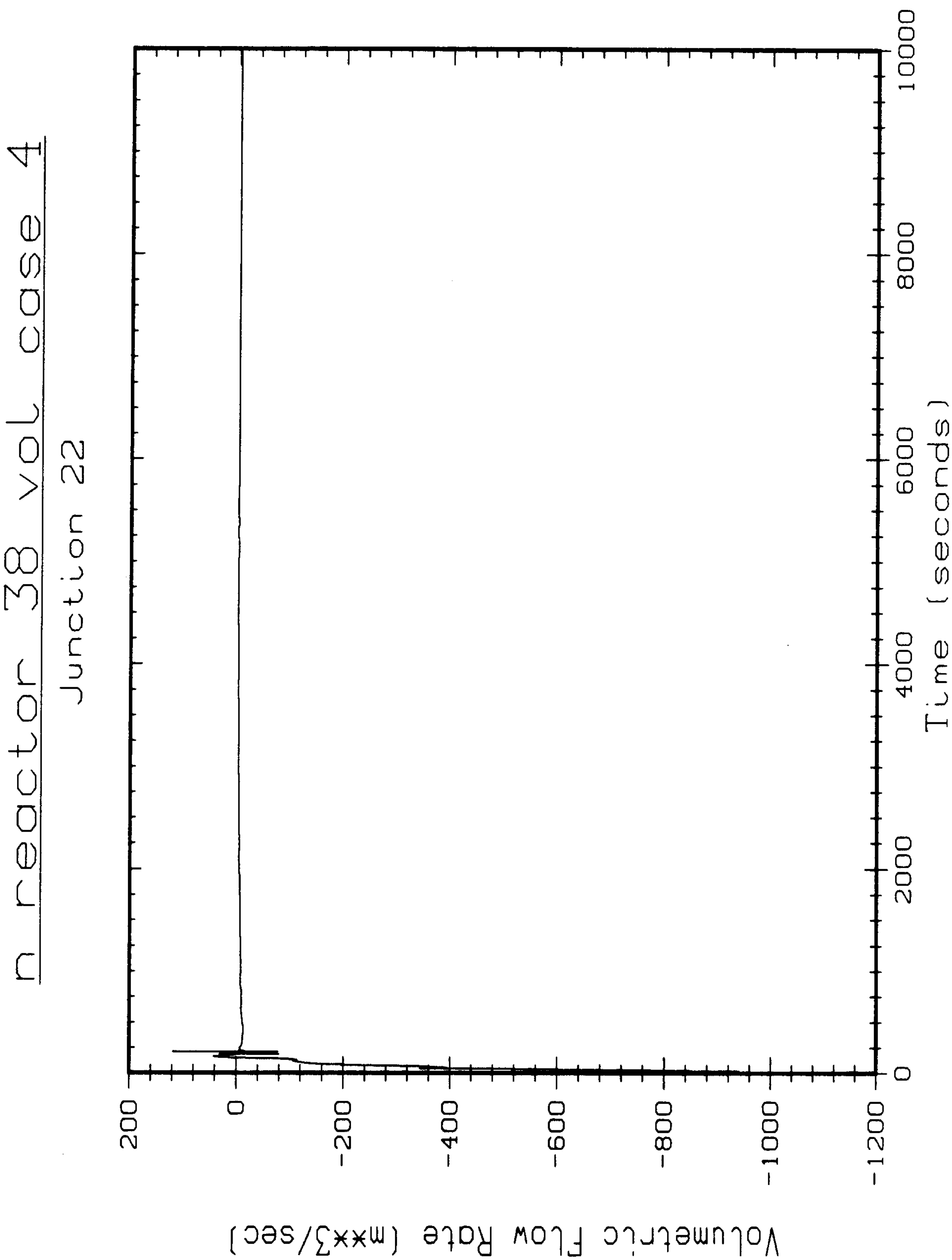

n reactor 38 vol case 4
Compartment 1
Mole Fractions
steam
O2
H2
Time (seconds)
Gas Mole Fractions
0
2000
4000
6000
8000
10000
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

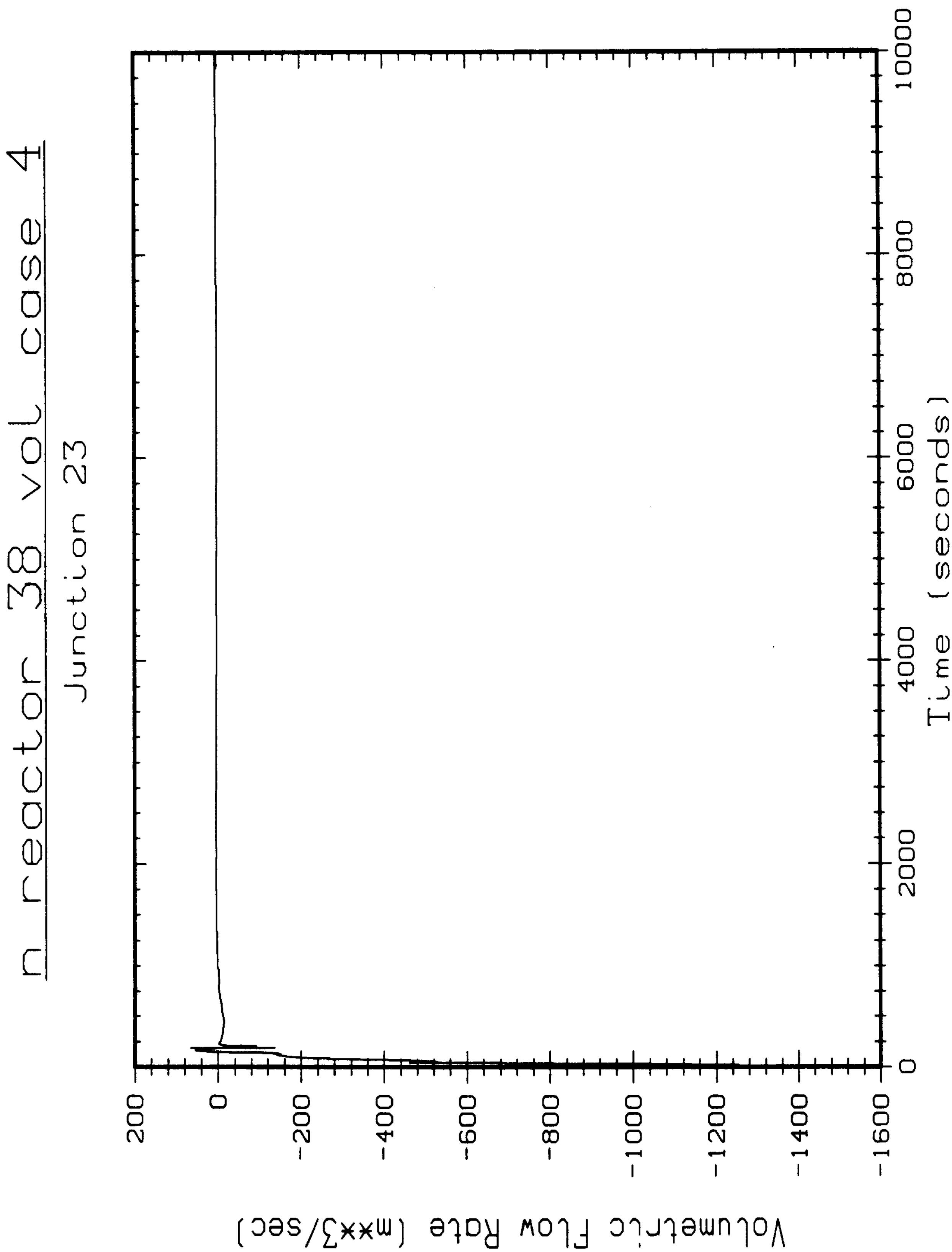

n reactor 38 vol case 4
Compartment 16
Mole Fractions
steam
O2
H2
Time (seconds)
0
2000
4000
6000
8000
10000
Gas Mole Fractions
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

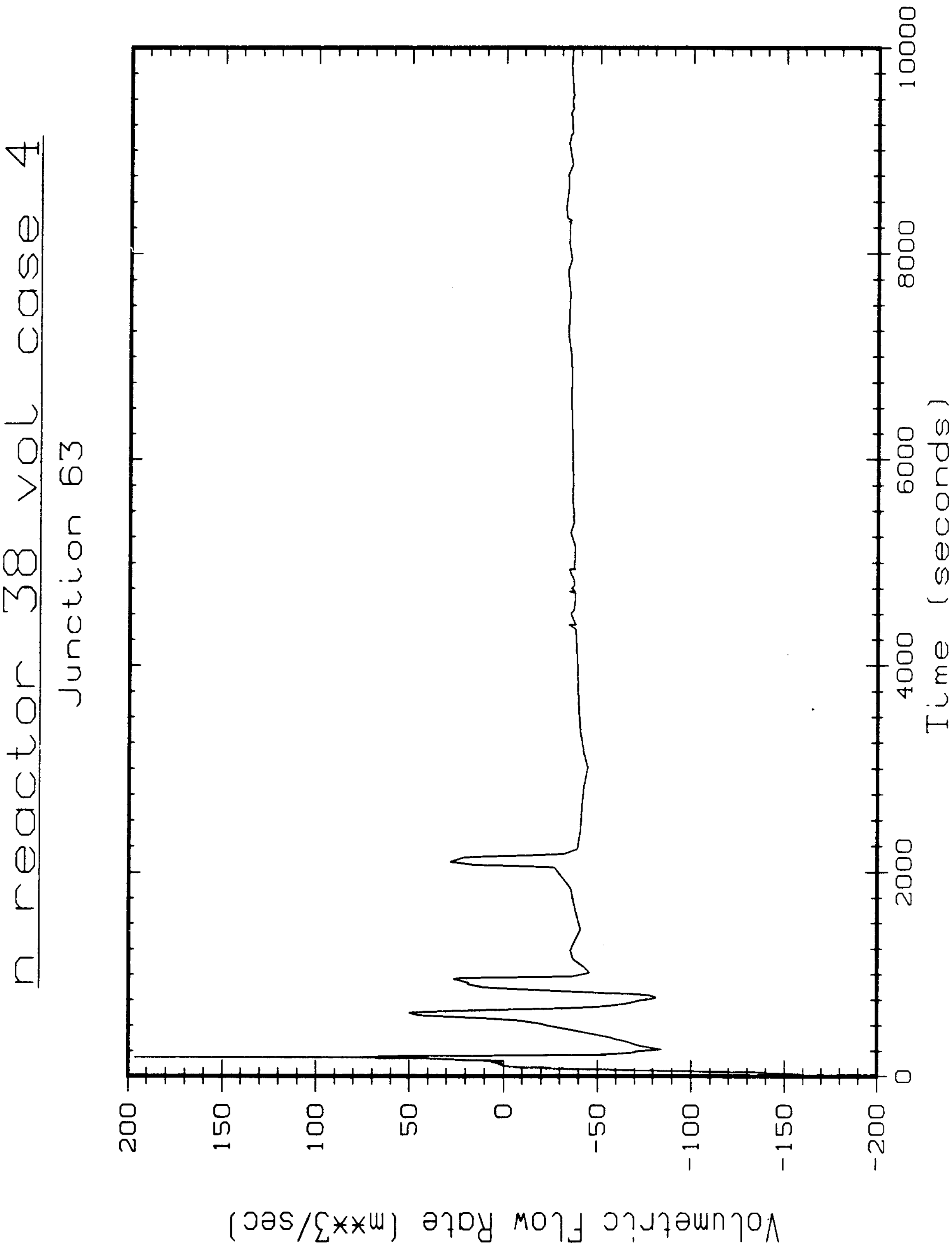

n reactor 38 vol case 4
Compartment 24
Mole Fractions
steam
O2
H2
Gas Mole Fractions
Time (seconds)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
2000
4000
6000
8000
10000


n reactor 38 vol case 4
Junction 1
Volumetric Flow Rate (m**3/sec)
Time (seconds)
1200
1000
800
600
400
200
0
-200
0
2000
4000
6000
8000
10000


n reactor 38 vol case 4
Junction 12
Volumetric Flow Rate (m**3/sec)
10
0
-10
-20
-30
-40
-50
-60
0
2000
4000
6000
8000
10000
Time (seconds)

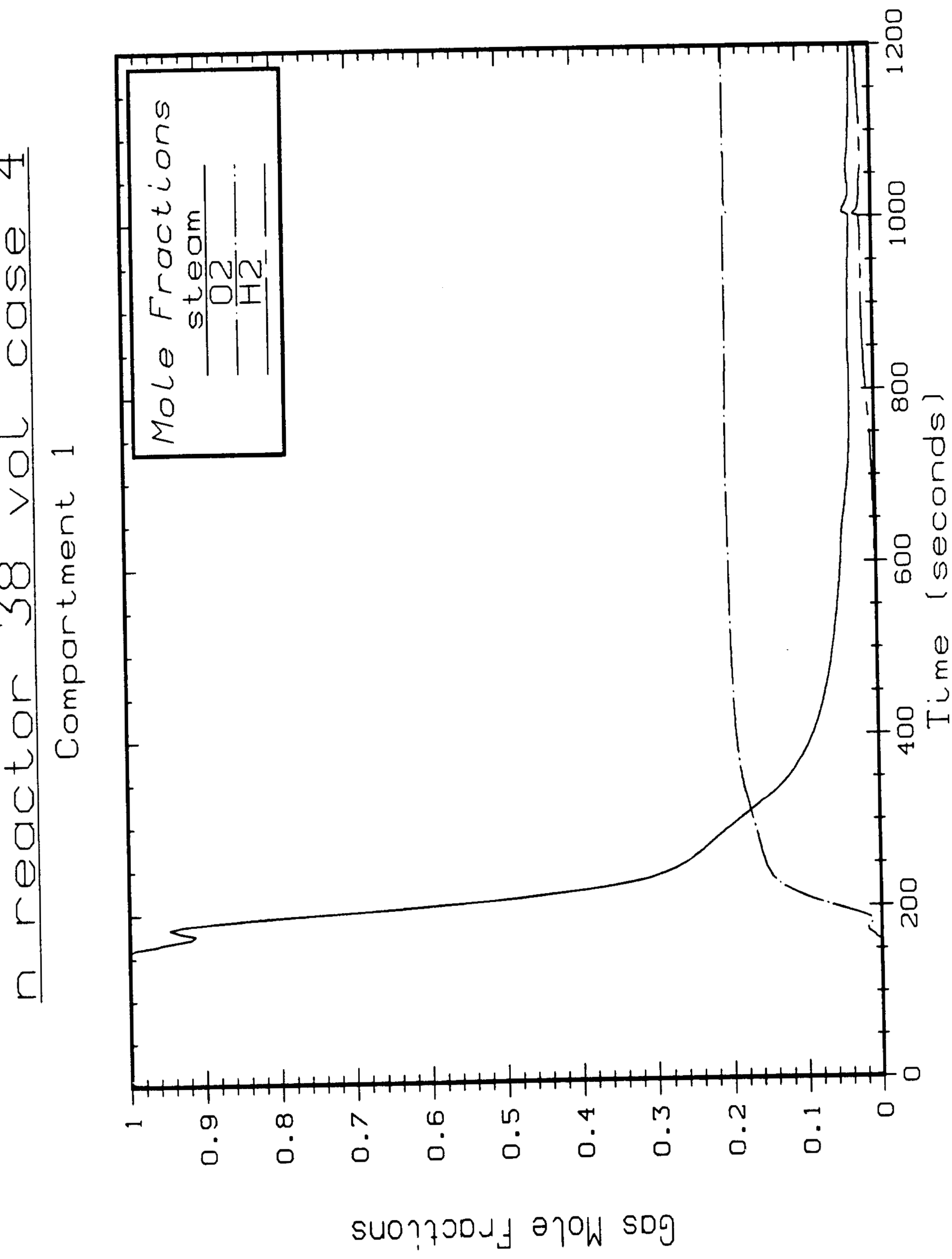

n reactor 38 vol case 4
Junction 22
Time (seconds)
0
2000
4000
6000
8000
10000
Volumetric Flow Rate (m**3/sec)
200
0
-200
-400
-600
-800
-1000
-1200

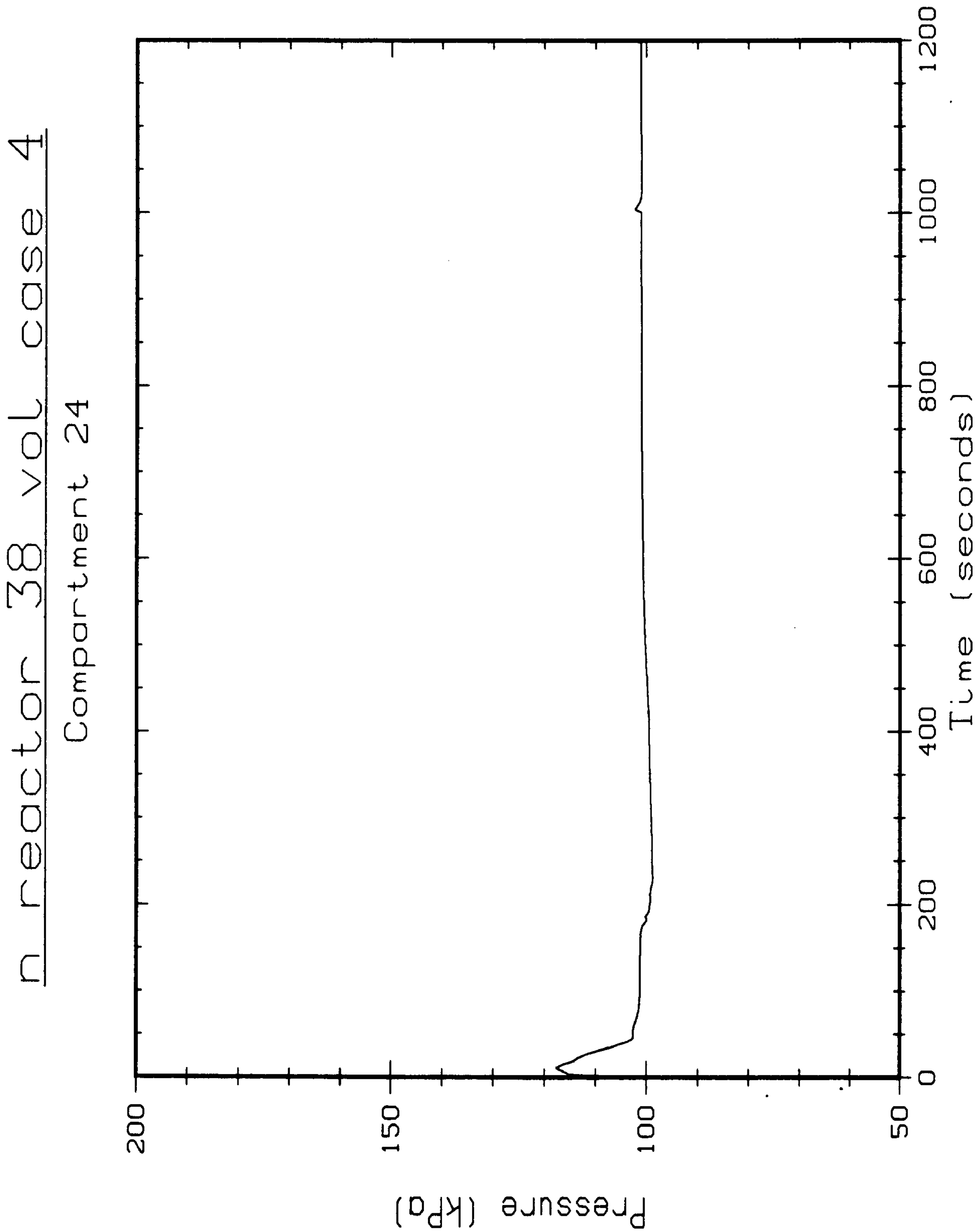

n reactor 38 vol case 4
Junction 23
Volumetric Flow Rate (m**3/sec)
200
0
-200
-400
-600
-800
-1000
-1200
-1400
-1600
Time (seconds)
0
2000
4000
6000
8000
10000

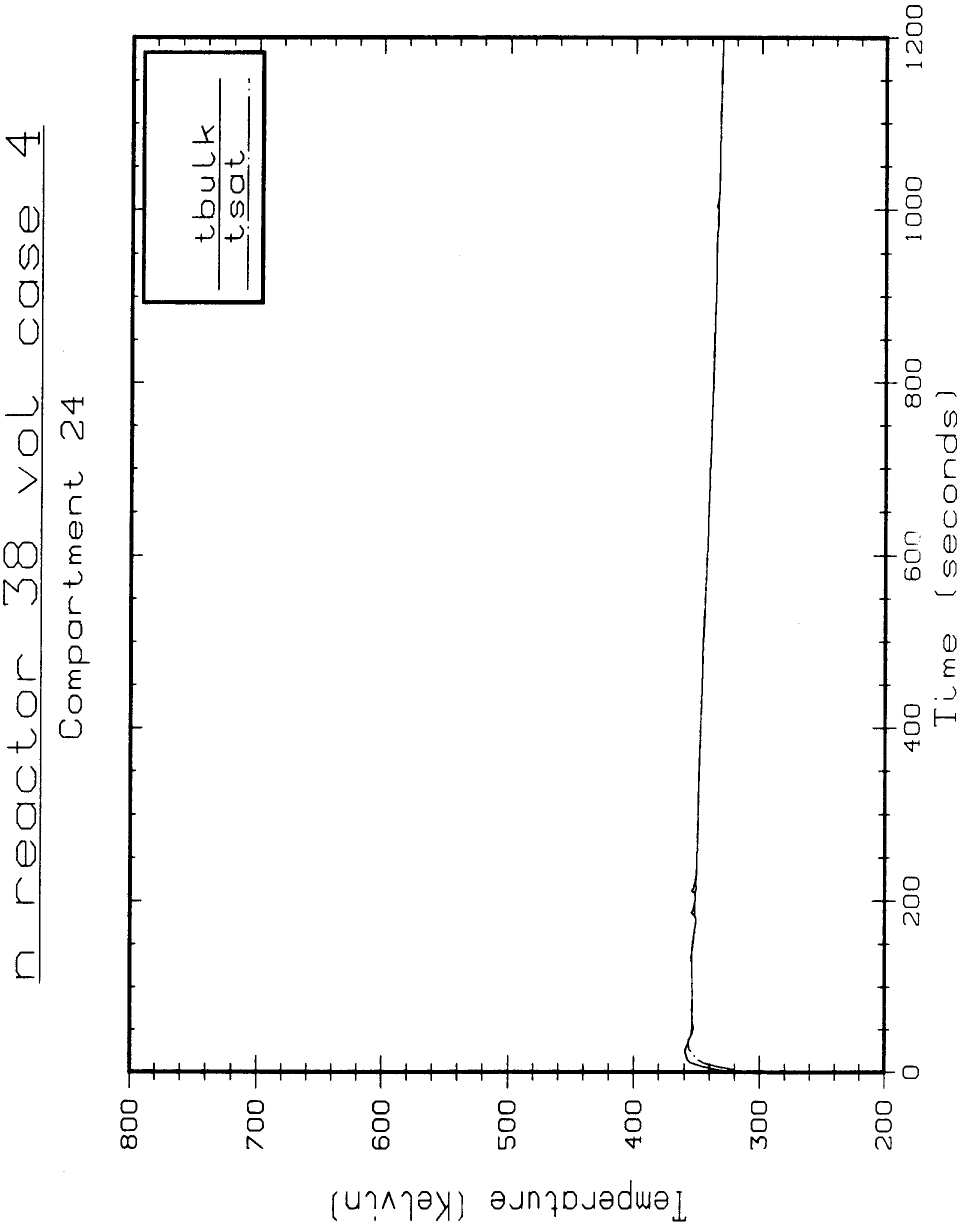

n reactor 38 vol case 4
Junction 63
Volumetric Flow Rate (m**3/sec)
200
150
100
50
0
-50
-100
-150
-200
Time (seconds)
0
2000
4000
6000
8000
10000

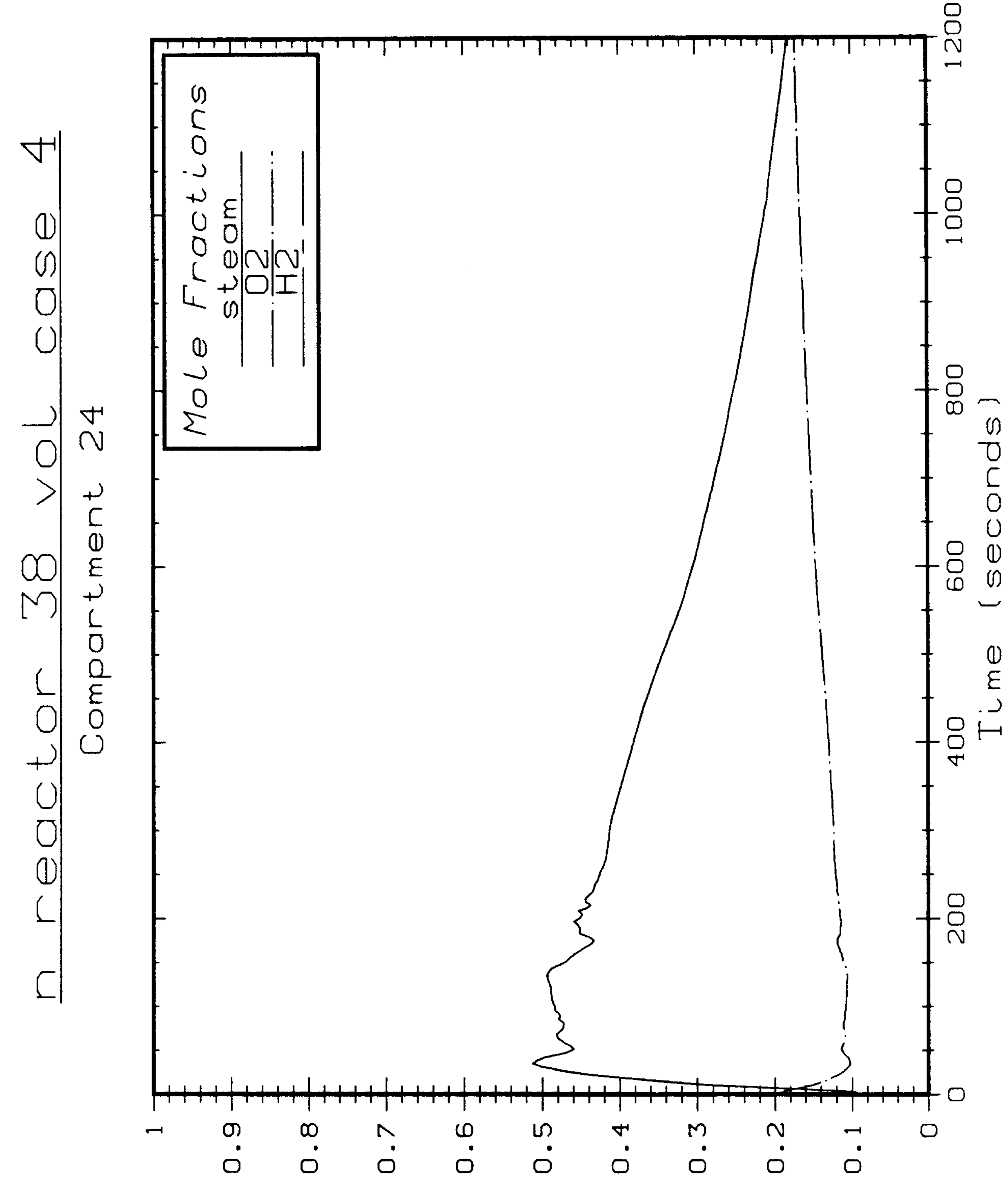
SELECTED PLOTS

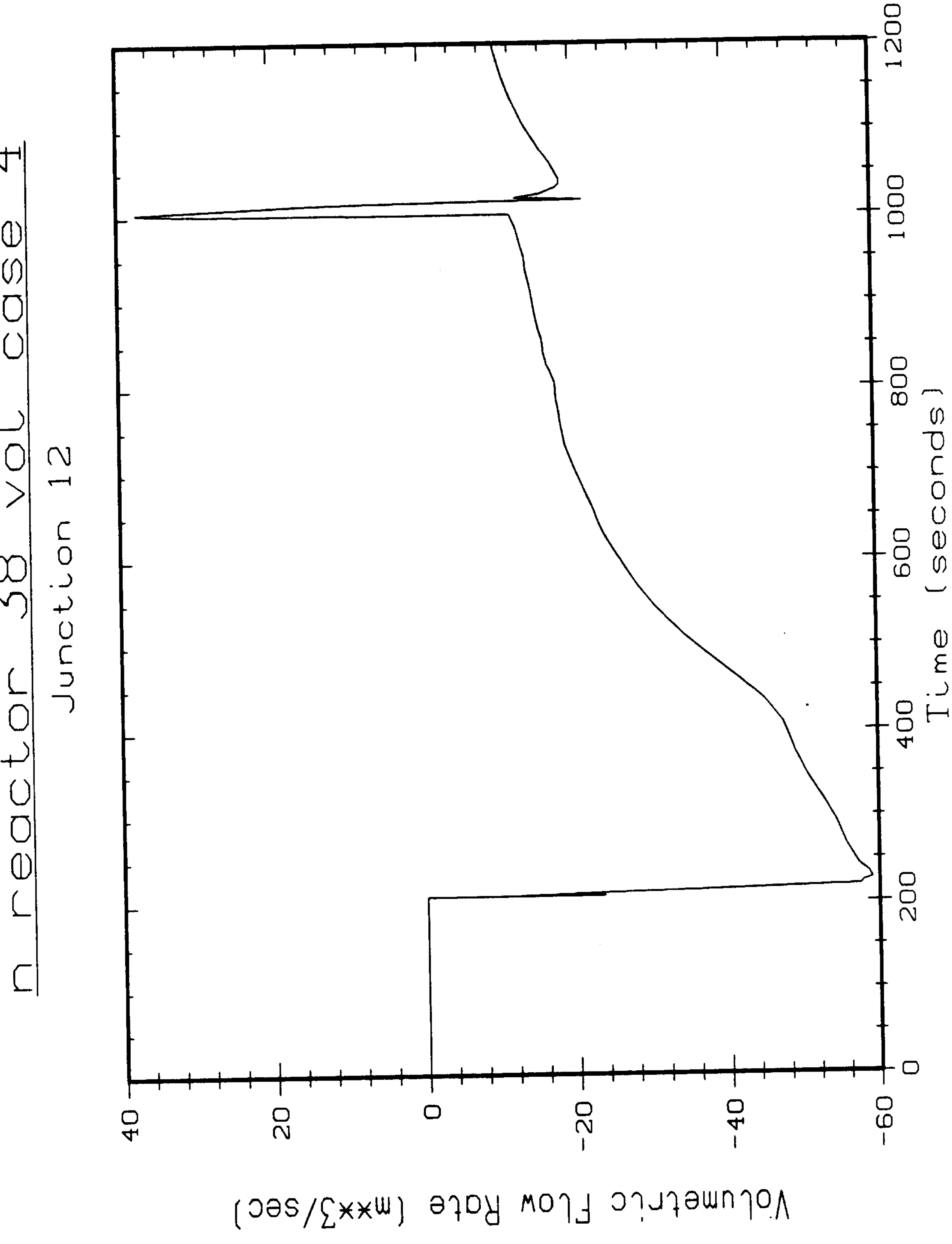
CASE 4B

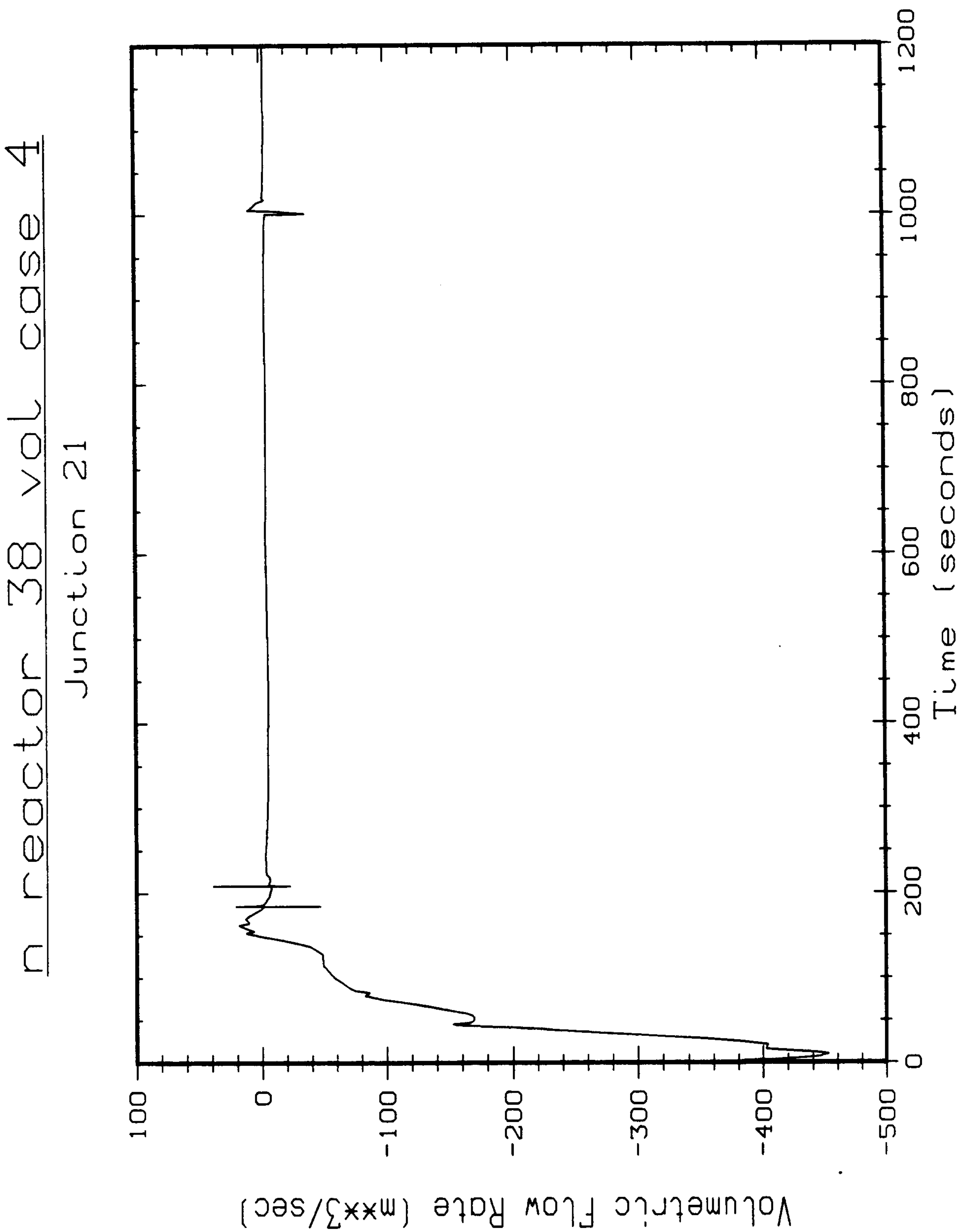

n reactor 38 vol case 4
Compartment 1
Mole Fractions
steam
O2
H2
Gas Mole Fractions
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Time (seconds)
0
200
400
600
800
1000
1200

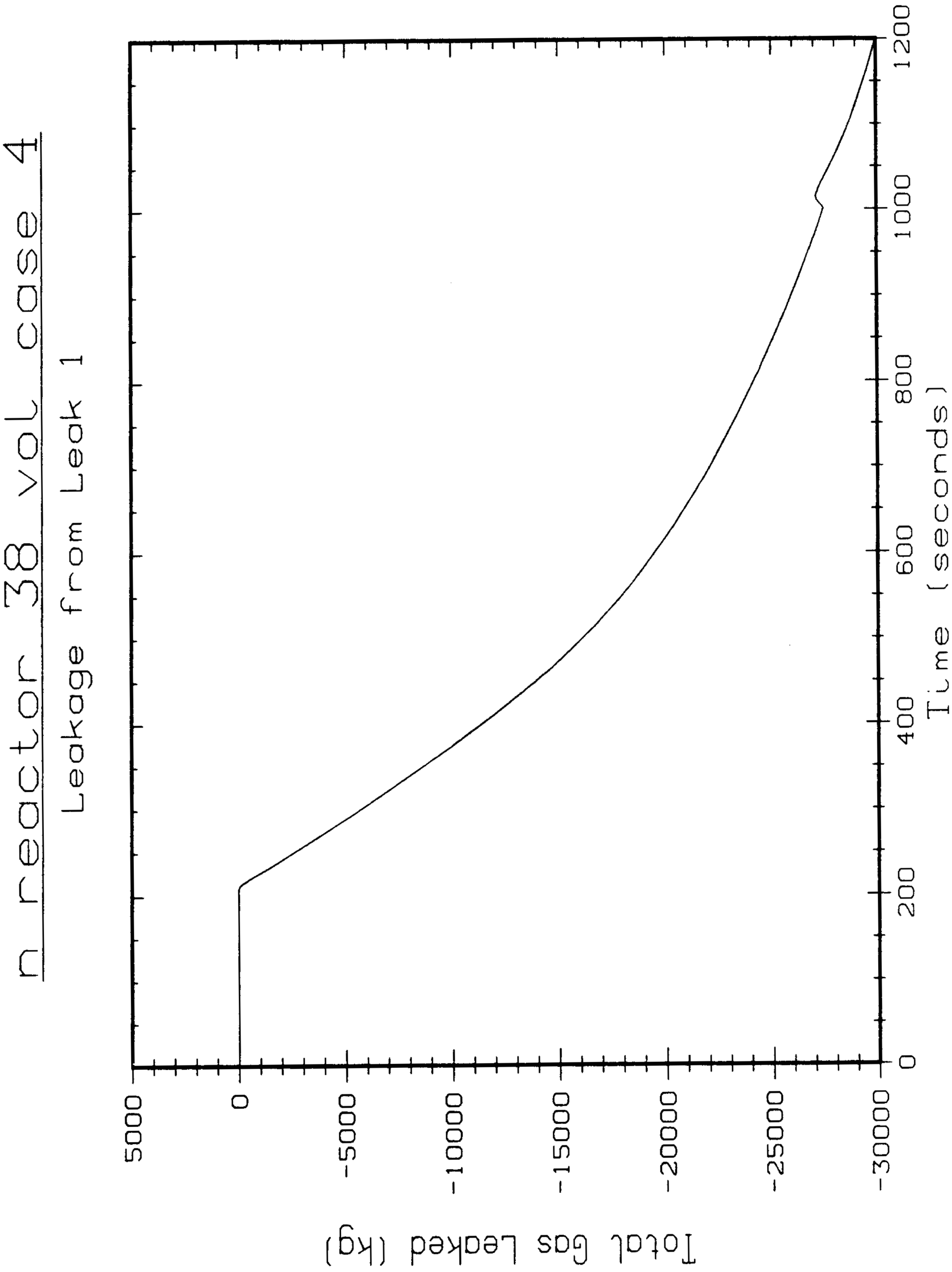

n reactor 38 vol case 4
Compartment 24
Pressure (kPa)
Time (seconds)
200
150
100
50
0
200
400
600
800
1000
1200

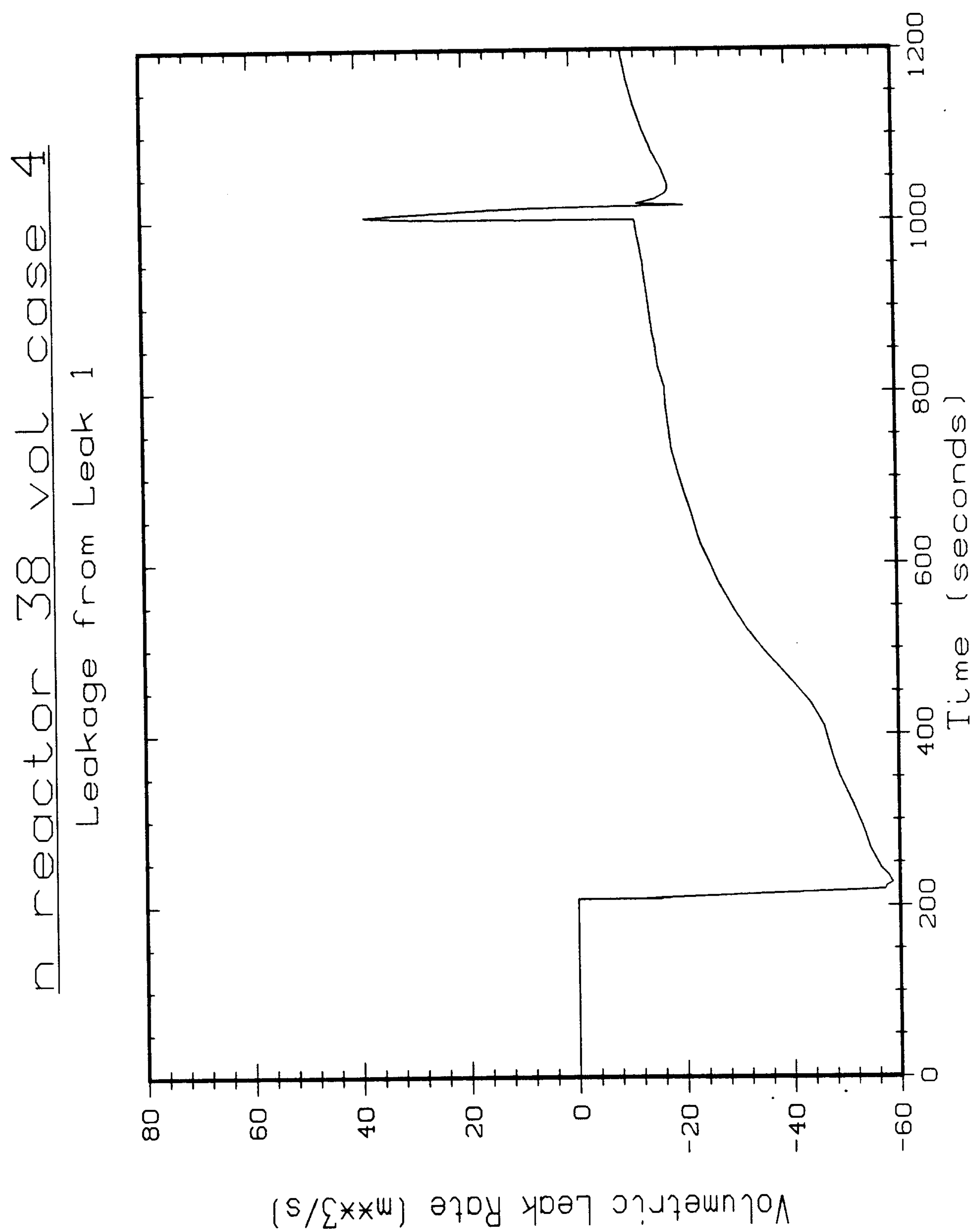

n reactor 38 vol case 4
Compartment 24
tbulk
tsat
Temperature (Kelvin)
800
700
600
500
400
300
200
Time (seconds)
0
200
400
600
800
1000
1200

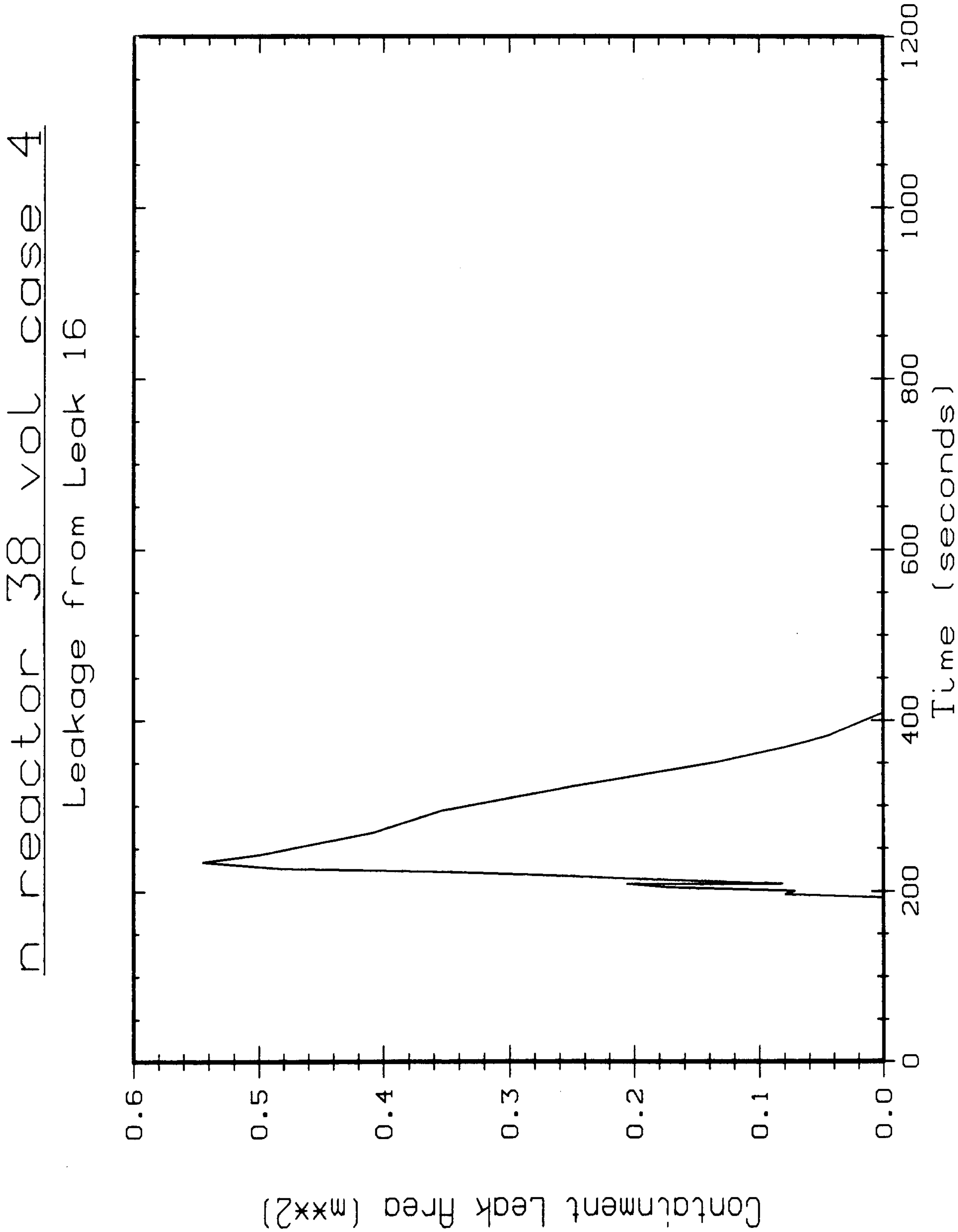

n reactor 38 vol case 4
Compartment 24
Mole Fractions
steam
O2
H2
Gas Mole Fractions
Time (seconds)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
200
400
600
800
1000
1200

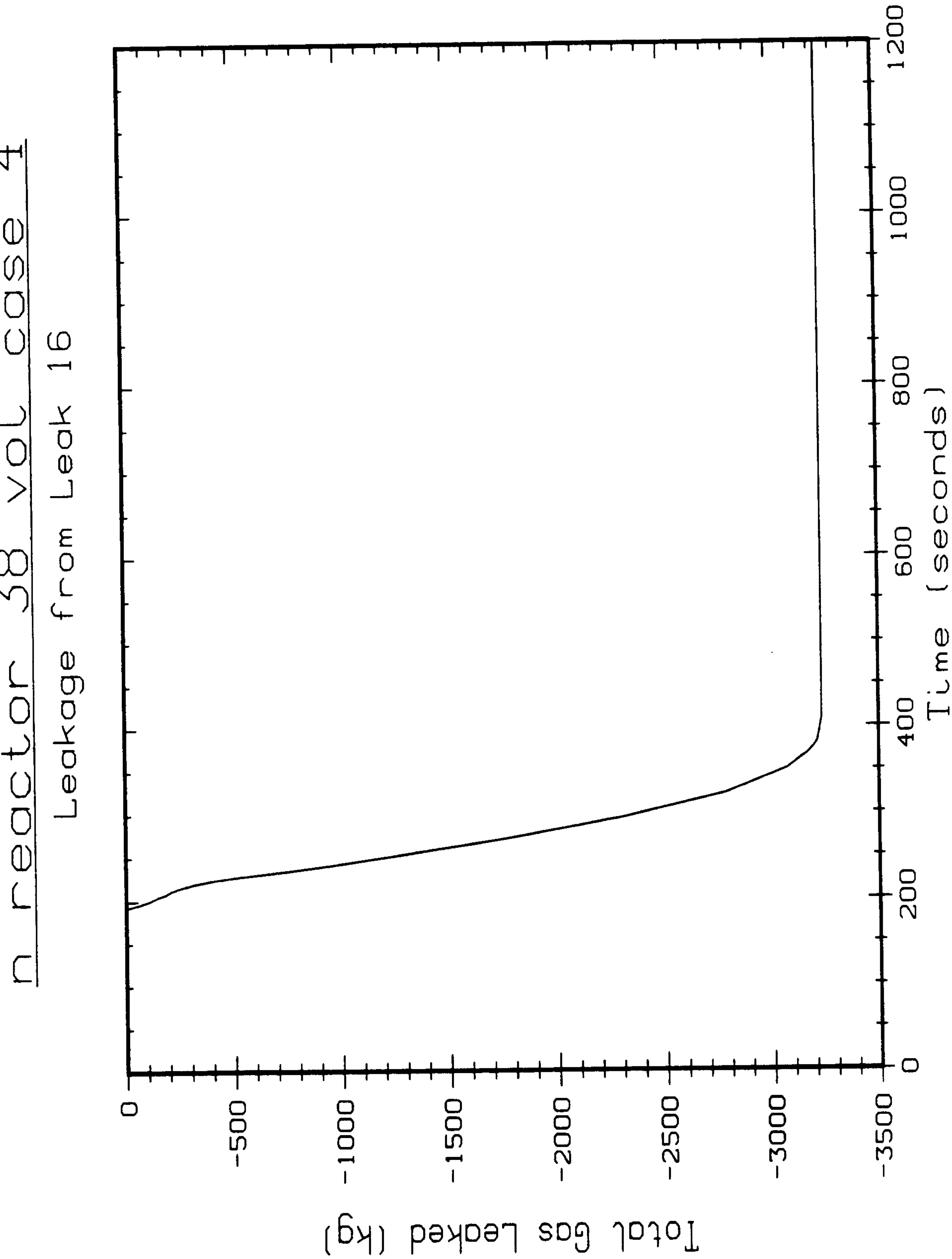

n reactor 38 vol case 4
Junction 12
Volumetric Flow Rate (m**3/sec)
40
20
0
-20
-40
-60
Time (seconds)
0
200
400
600
800
1000
1200


n reactor 38 vol case 4
Junction 21
Time (seconds)
Volumetric Flow Rate (m**3/sec)
0
200
400
600
800
1000
1200
100
0
-100
-200
-300
-400
-500


n reactor 38 vol case 4
Leakage from Leak 1
Time (seconds)
Total Gas Leaked (kg)
0
200
400
600
800
1000
1200
5000
0
-5000
-10000
-15000
-20000
-25000
-30000

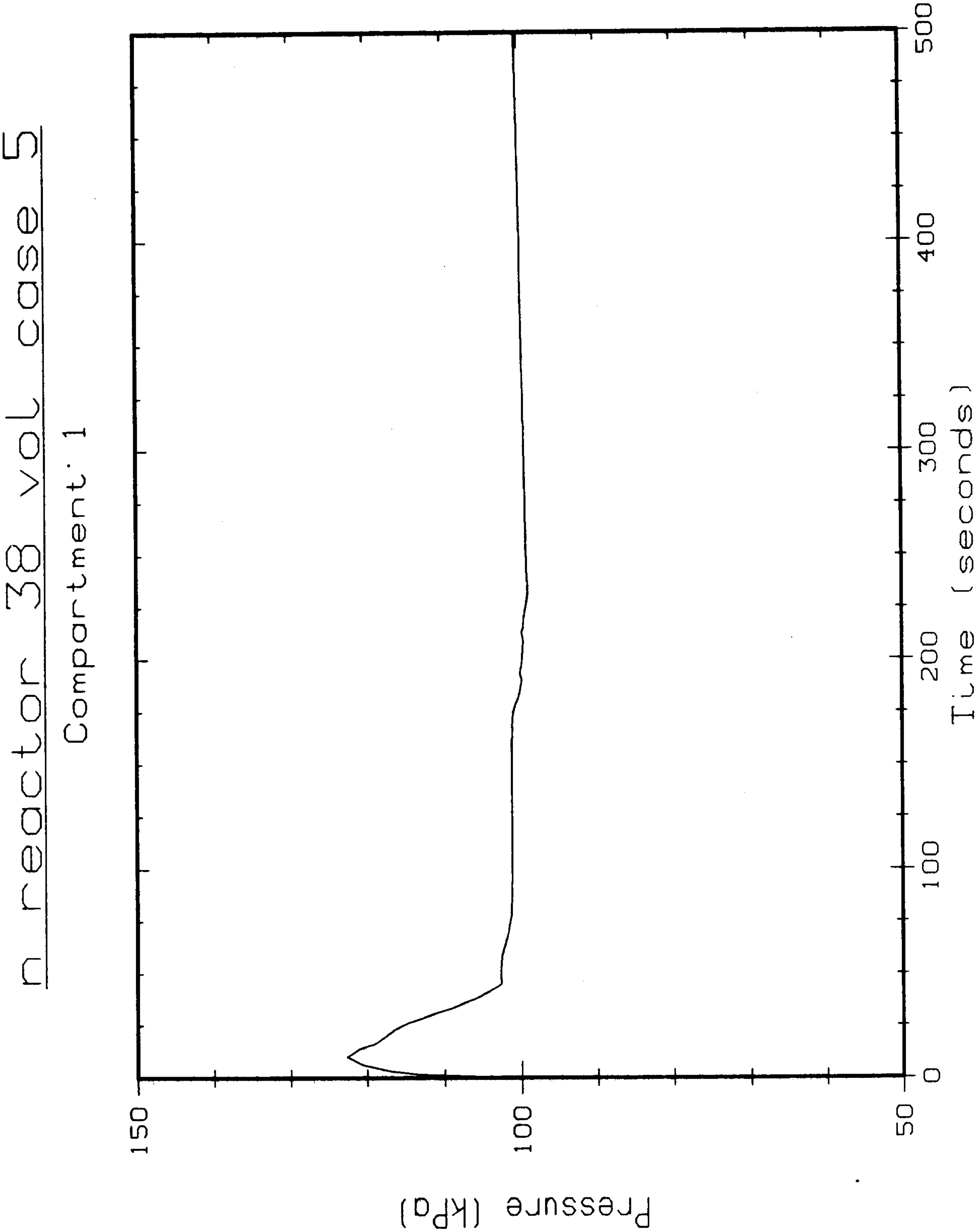

n reactor 38 vol case 4
Leakage from Leak 1
Volumetric Leak Rate (m**3/s)
Time (seconds)
80
60
40
20
0
-20
-40
-60
0
200
400
600
800
1000
1200

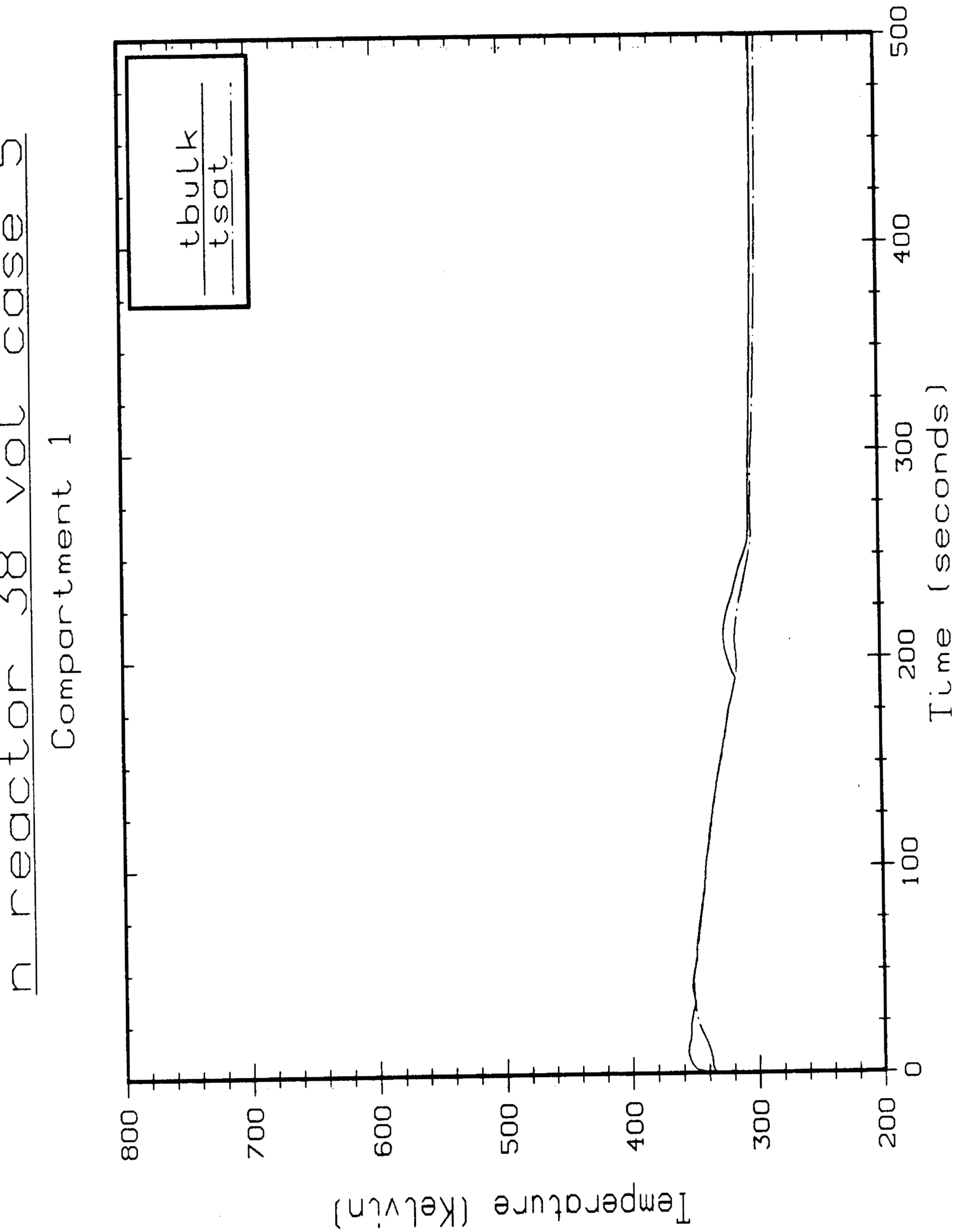

n reactor 38 vol case 4
Leakage from Leak 16
Containment Leak Area (m**2)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Time (seconds)
0
200
400
600
800
1000
1200

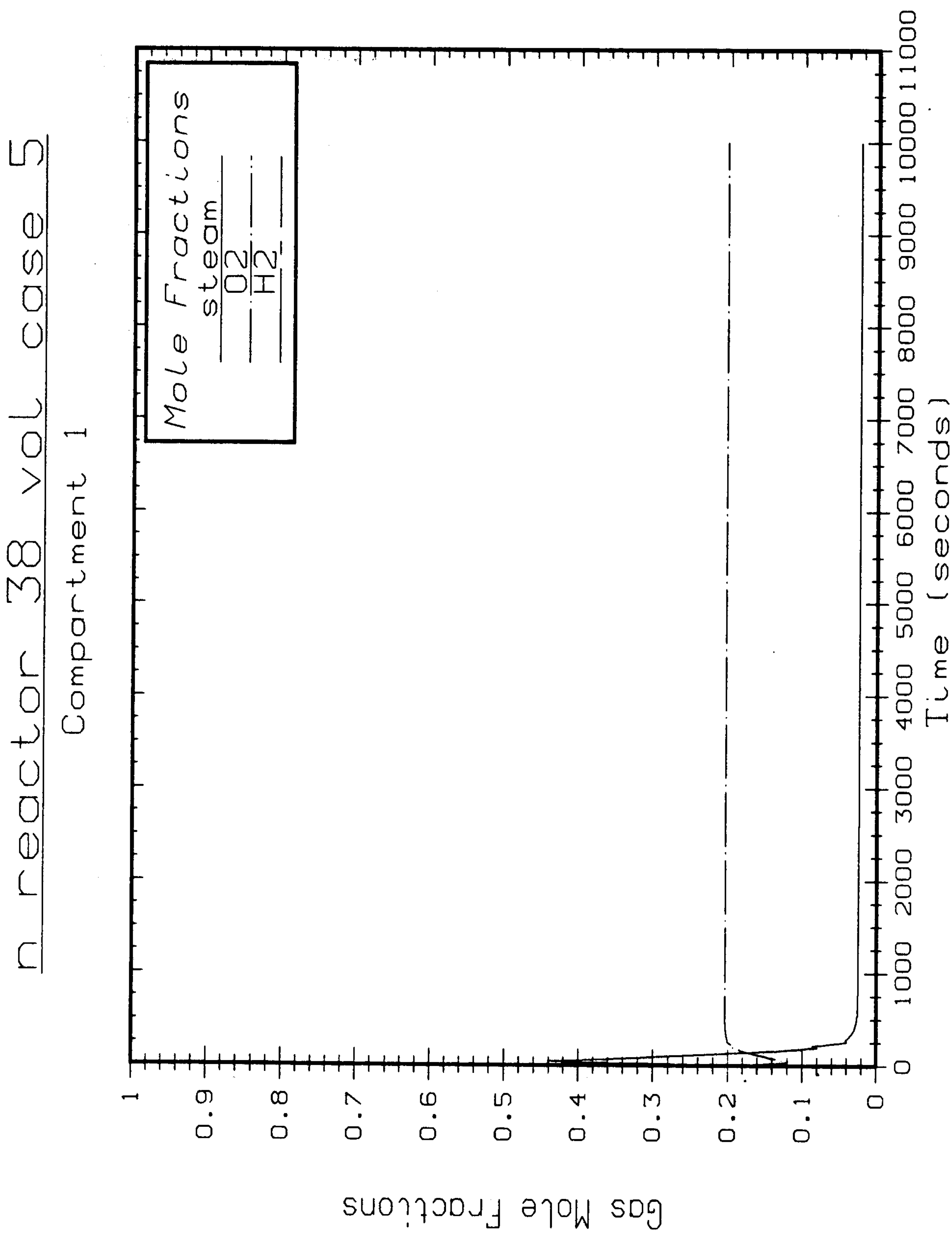

n reactor 38 vol case 4
Leakage from Leak 16
Total Gas Leaked (kg)
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
0
200
400
600
800
1000
1200
Time (seconds)

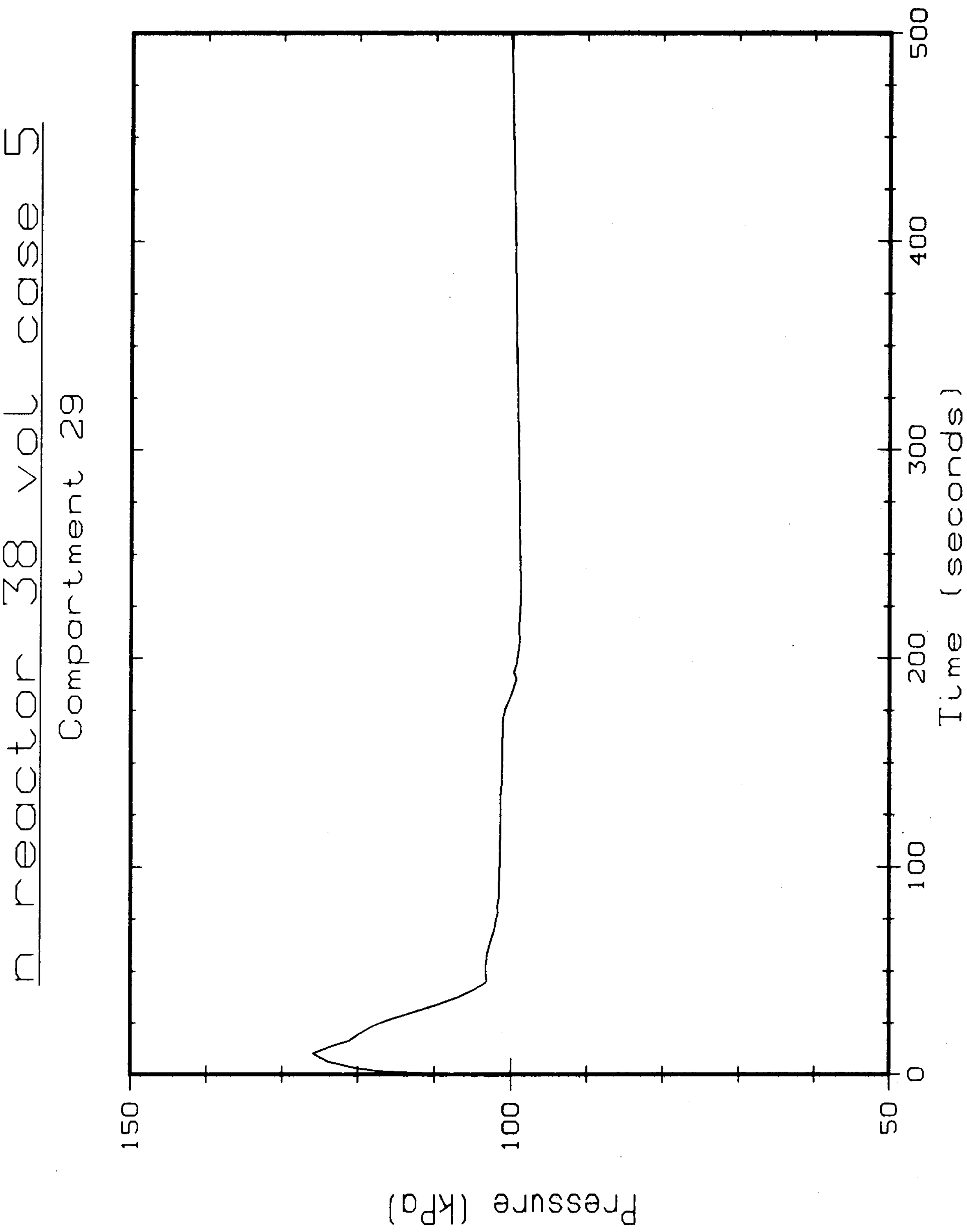
SELECTED PLOTS

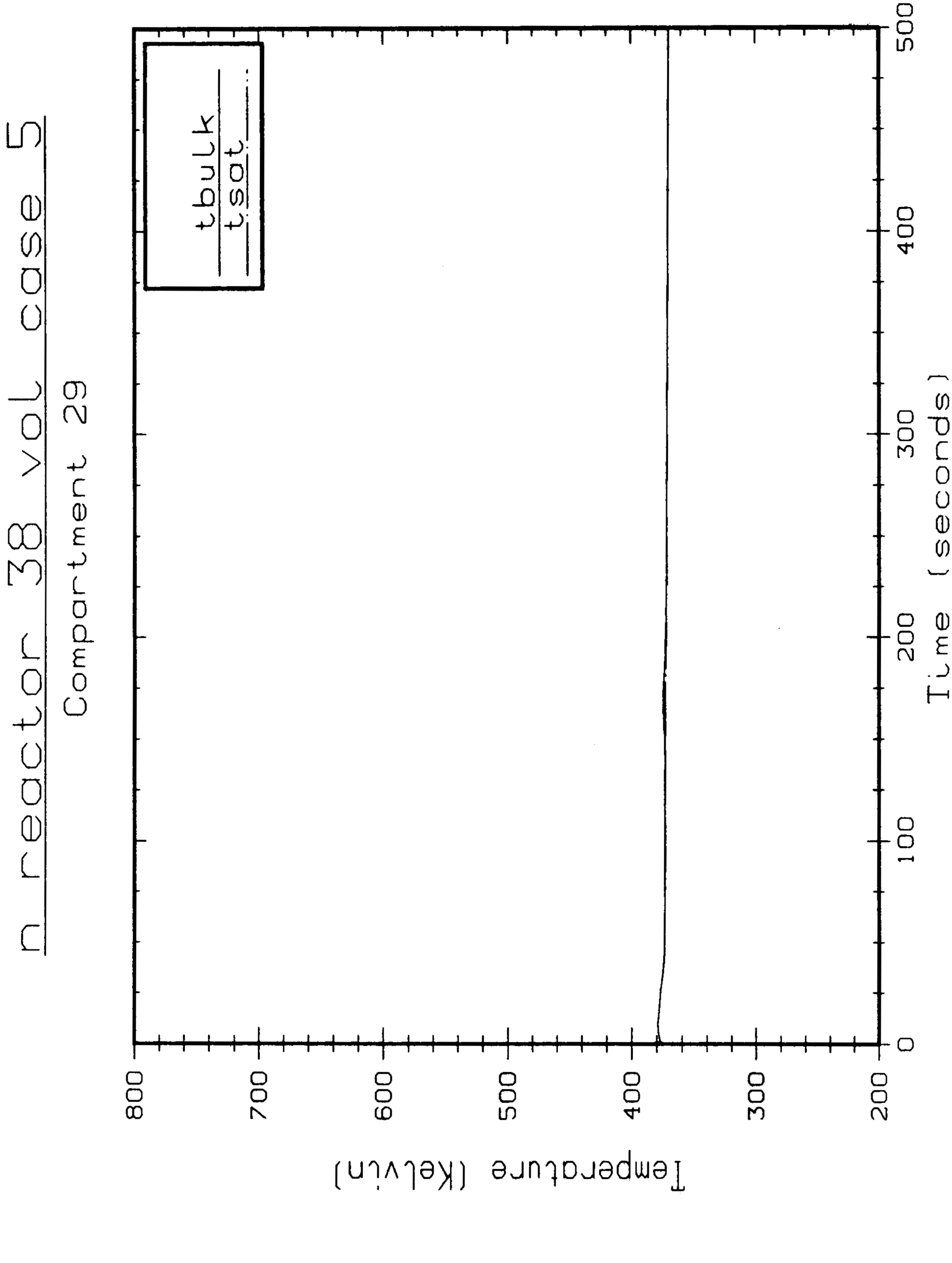
CASE 5

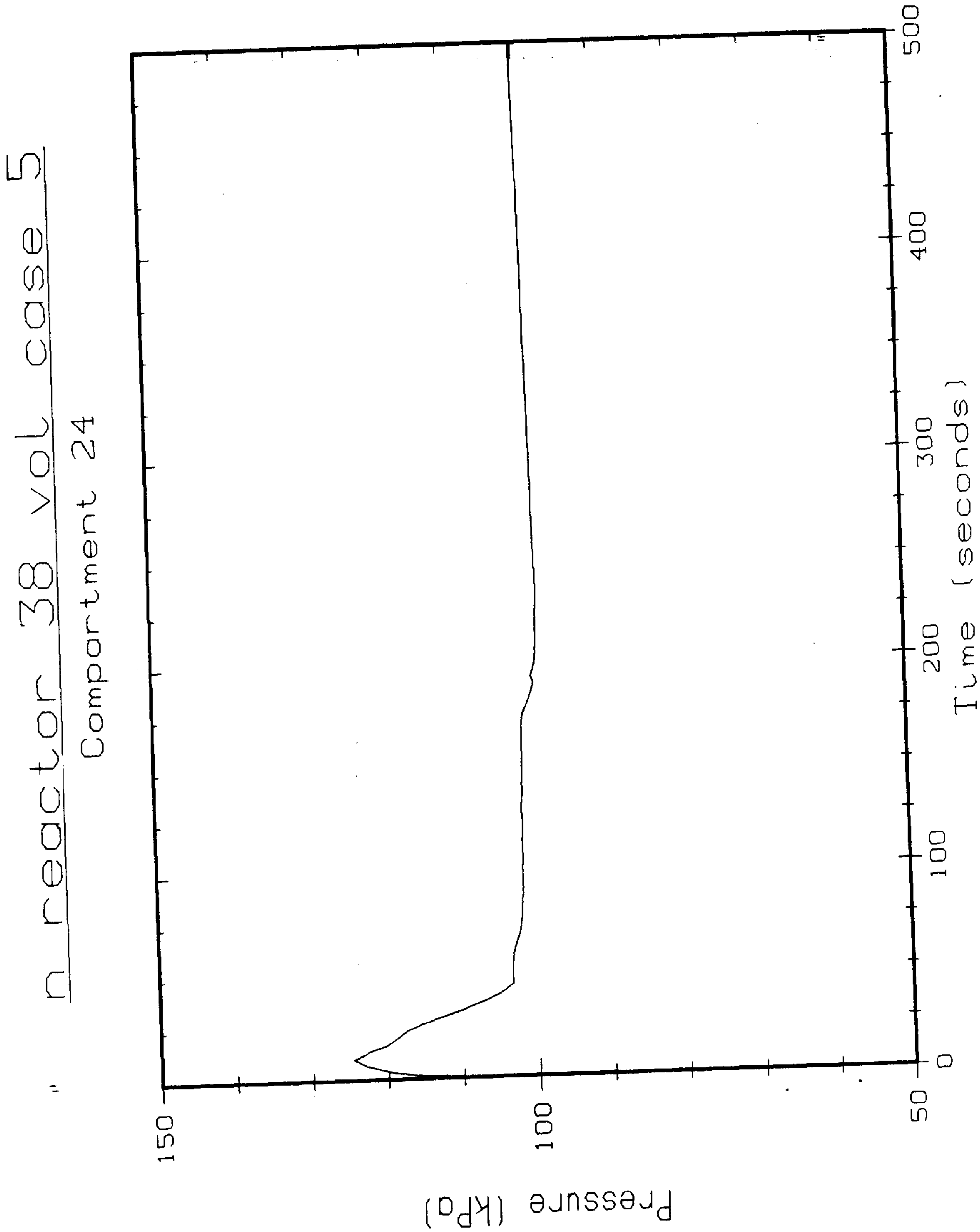

n reactor 38 vol case 5
Compartment 1
Pressure (kPa)
150
100
50
Time (seconds)
0
100
200
300
400
500

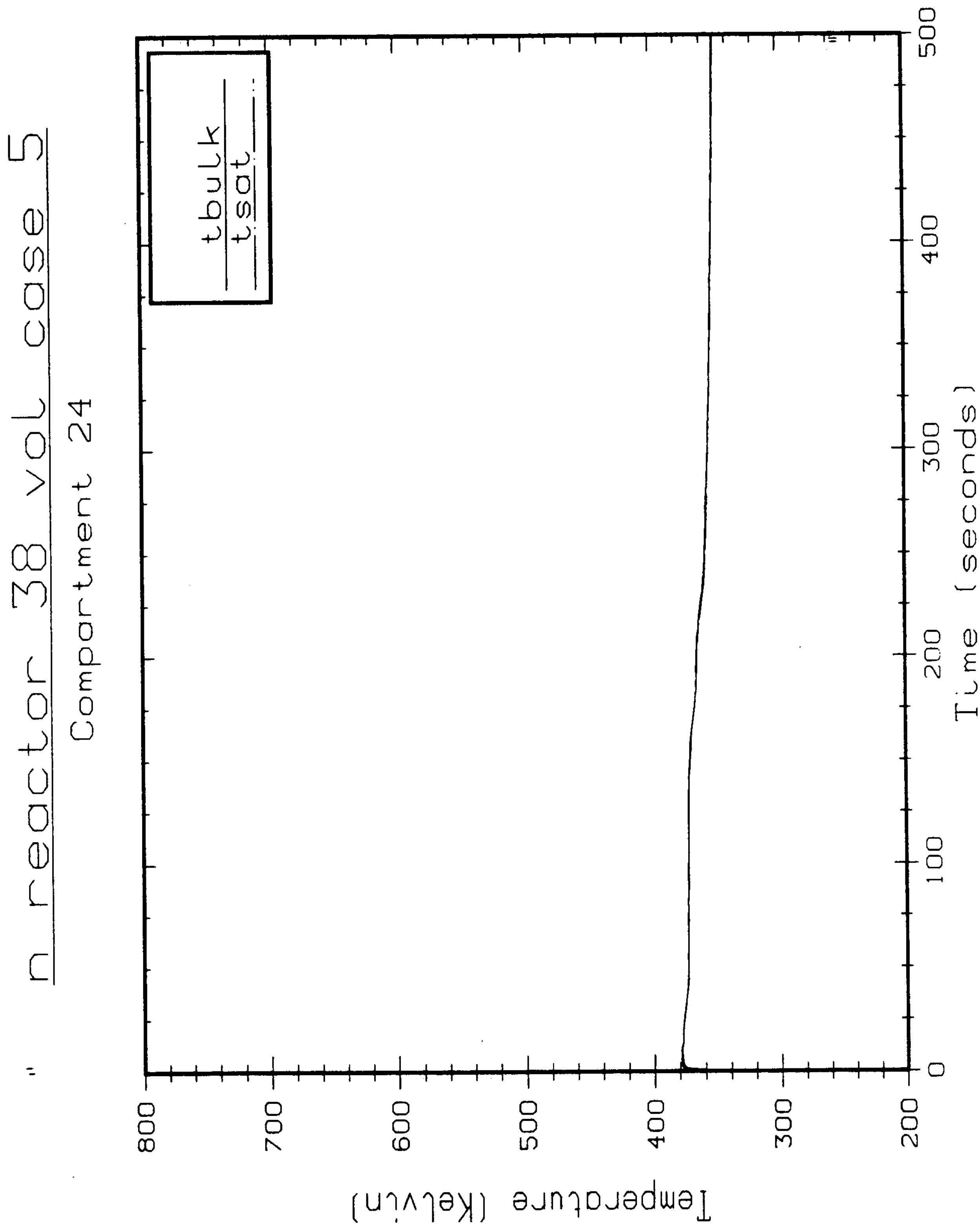

n reactor 38 vol case 5
Compartment 1
tbulk
tsat
Time (seconds)
0
100
200
300
400
500
Temperature (Kelvin)
200
300
400
500
600
700
800

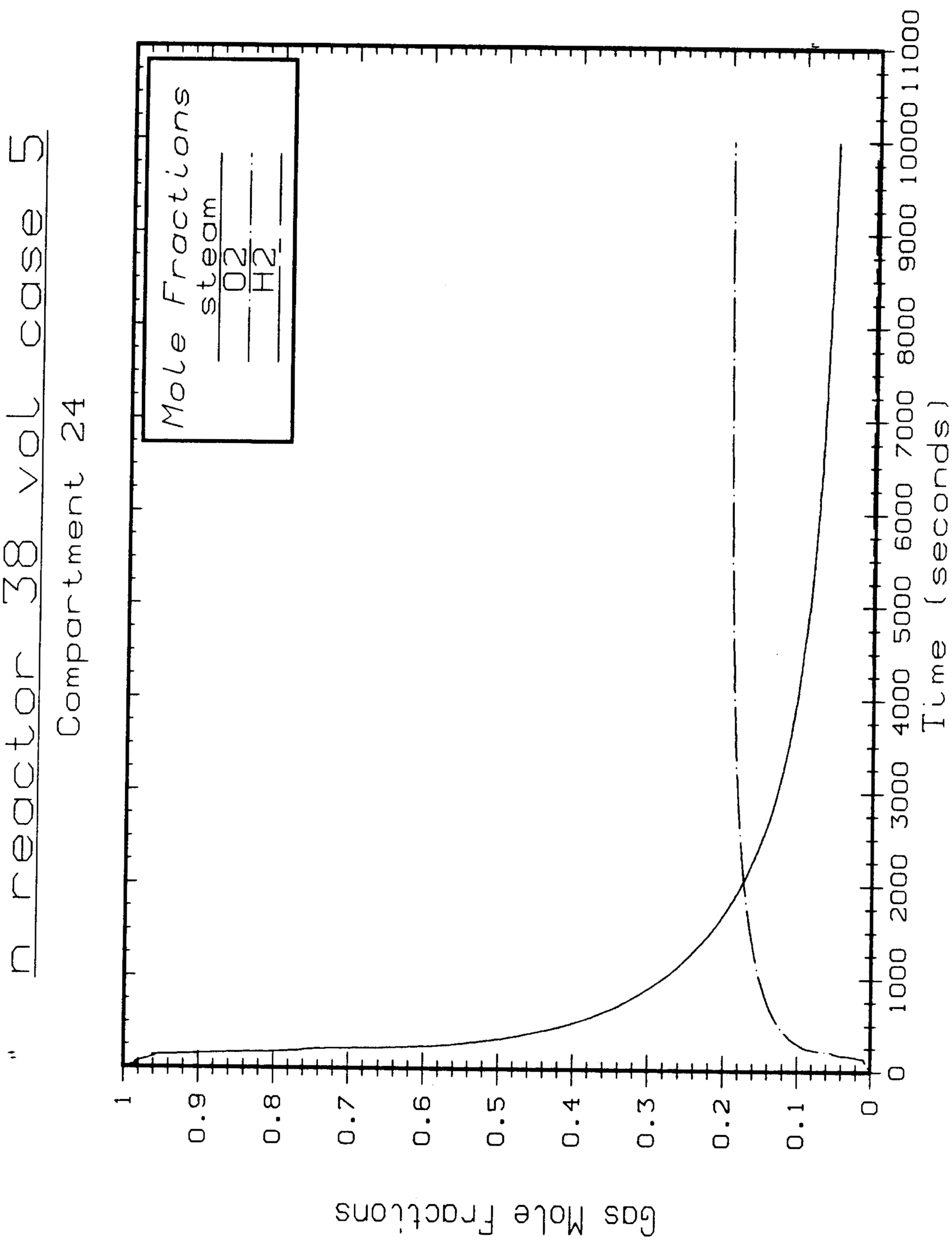

n reactor 38 vol case 5
Compartment 1
Mole Fractions
steam
O2
H2
Gas Mole Fractions
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

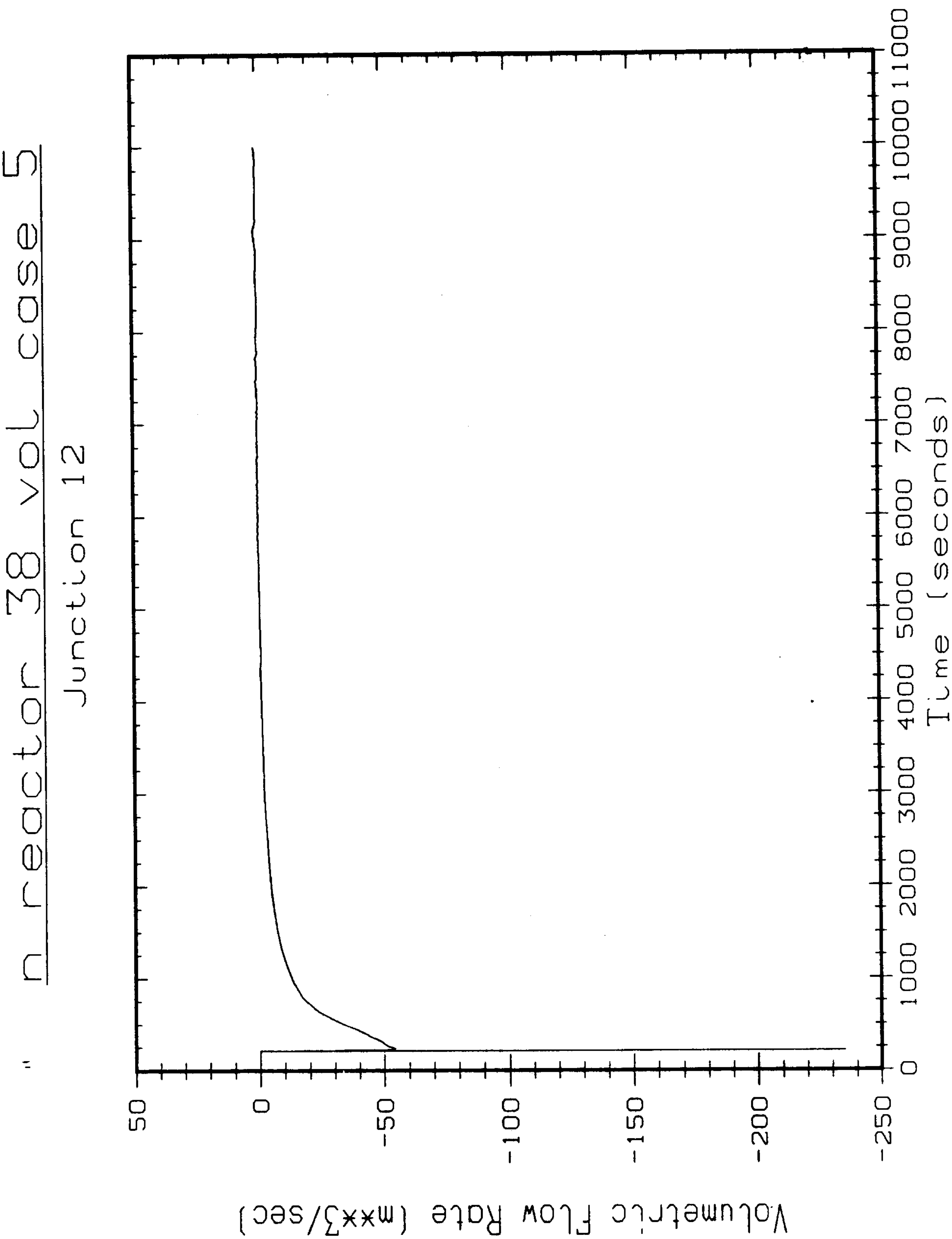

n reactor 38 vol case 5
Compartment 29
Pressure (kPa)
Time (seconds)
150
100
50
0
100
200
300
400
500

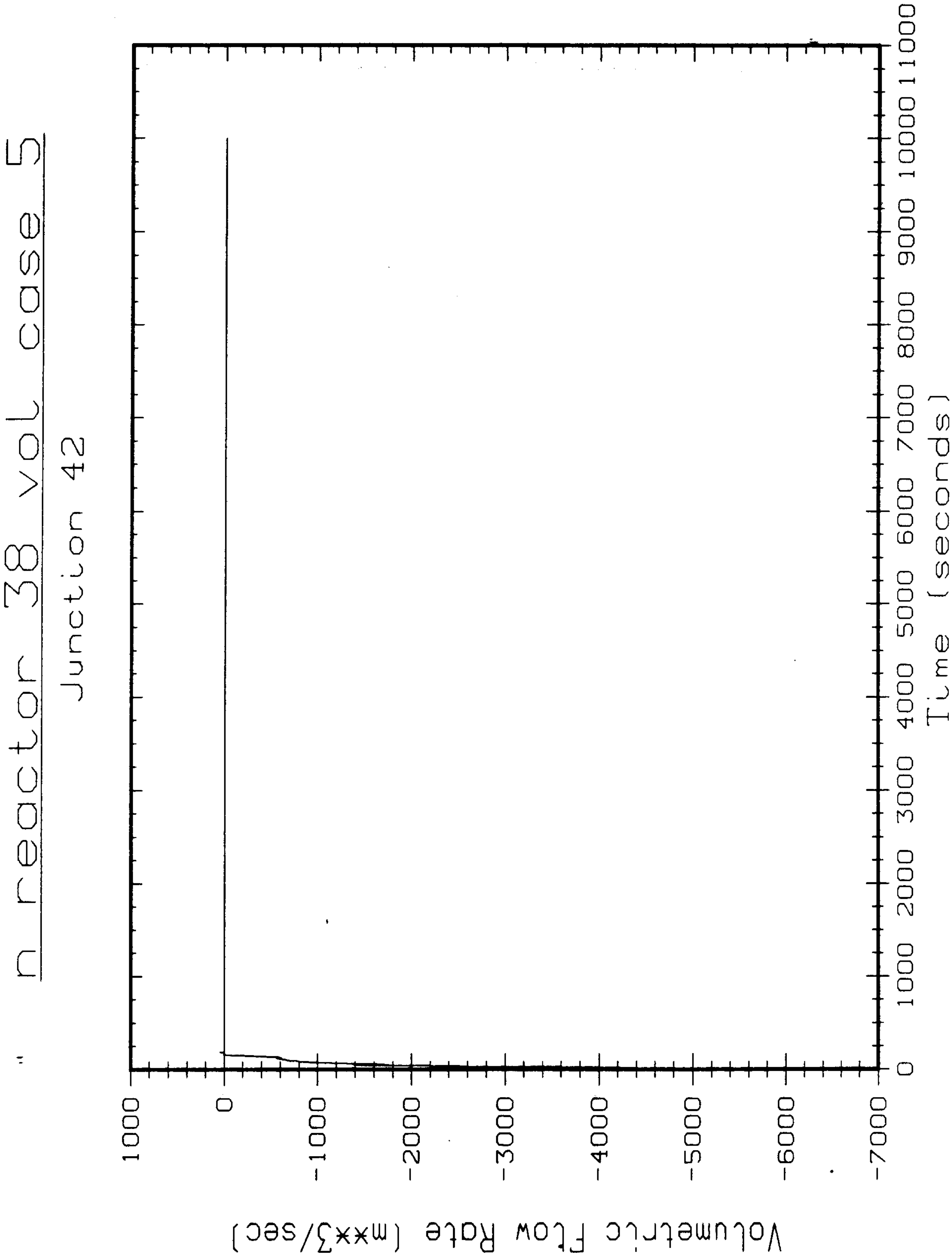

n reactor 38 vol case 5
Compartment 29
tbulk
tsat
Time (seconds)
Temperature (Kelvin)
0
100
200
300
400
500
200
300
400
500
600
700
800

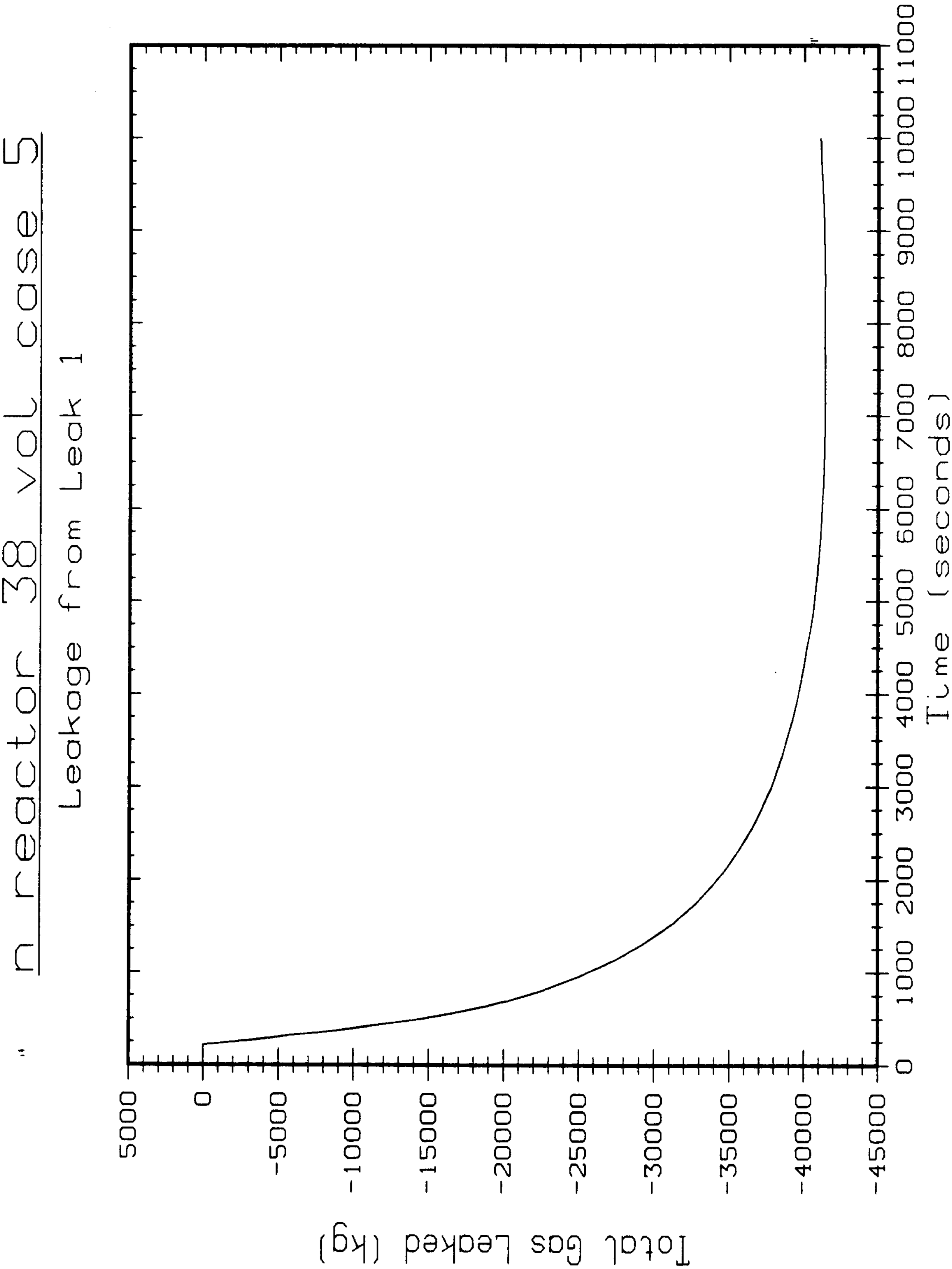

n reactor 38 vol case 5
Compartment 24
Pressure (kPa)
150
100
50
Time (seconds)
0
100
200
300
400
500


n reactor 38 vol case 5
Compartment 24
tbulk
tsat
800
700
600
500
400
300
200
Temperature (Kelvin)
0
100
200
300
400
500
Time (seconds)


n reactor 38 vol case 5
Compartment 24
Mole Fractions
steam
O2
H2
Gas Mole Fractions
Time (seconds)
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000

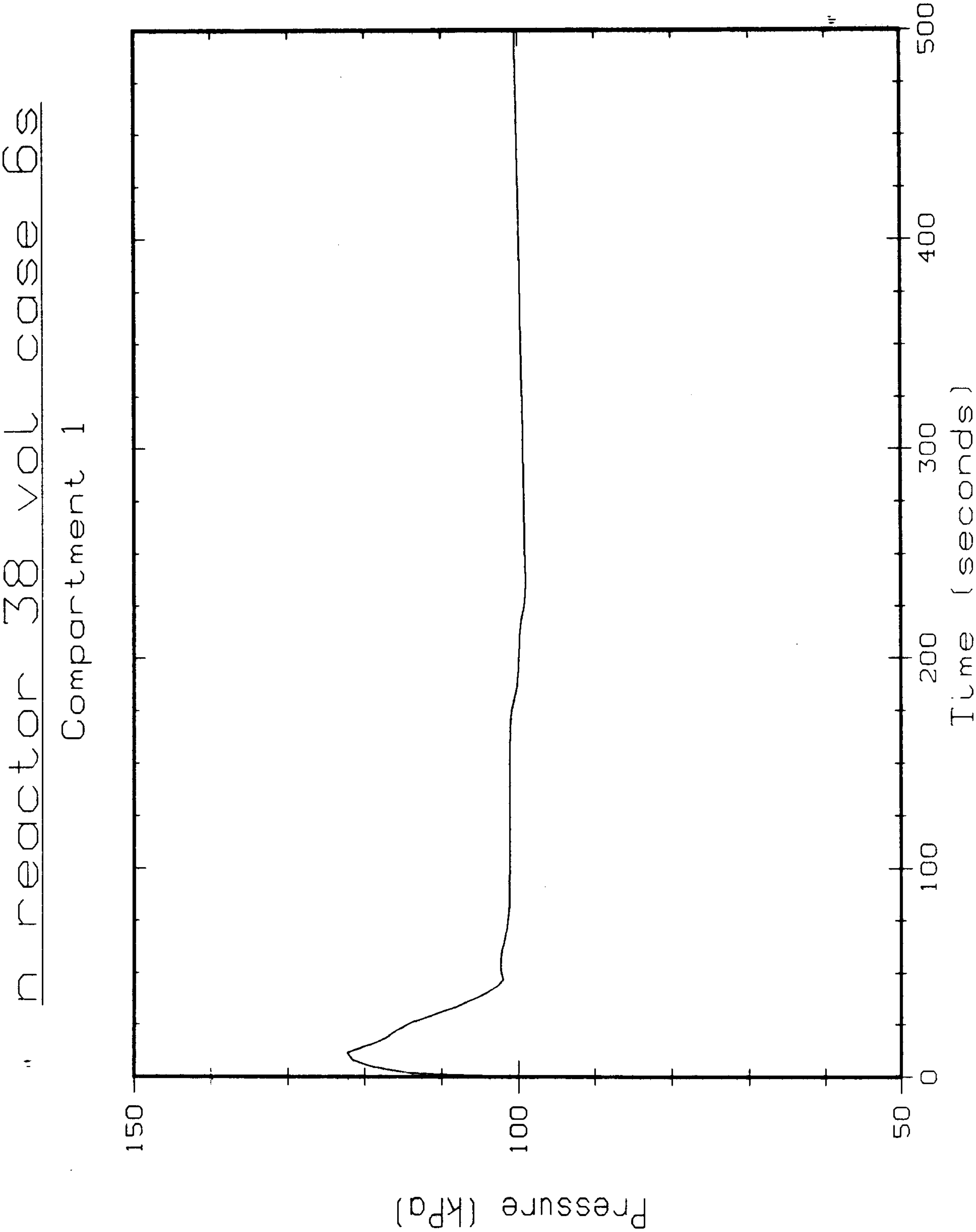

n reactor 38 vol case 5
Junction 12
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
Time (seconds)
50
0
-50
-100
-150
-200
-250
Volumetric Flow Rate (m**3/sec)

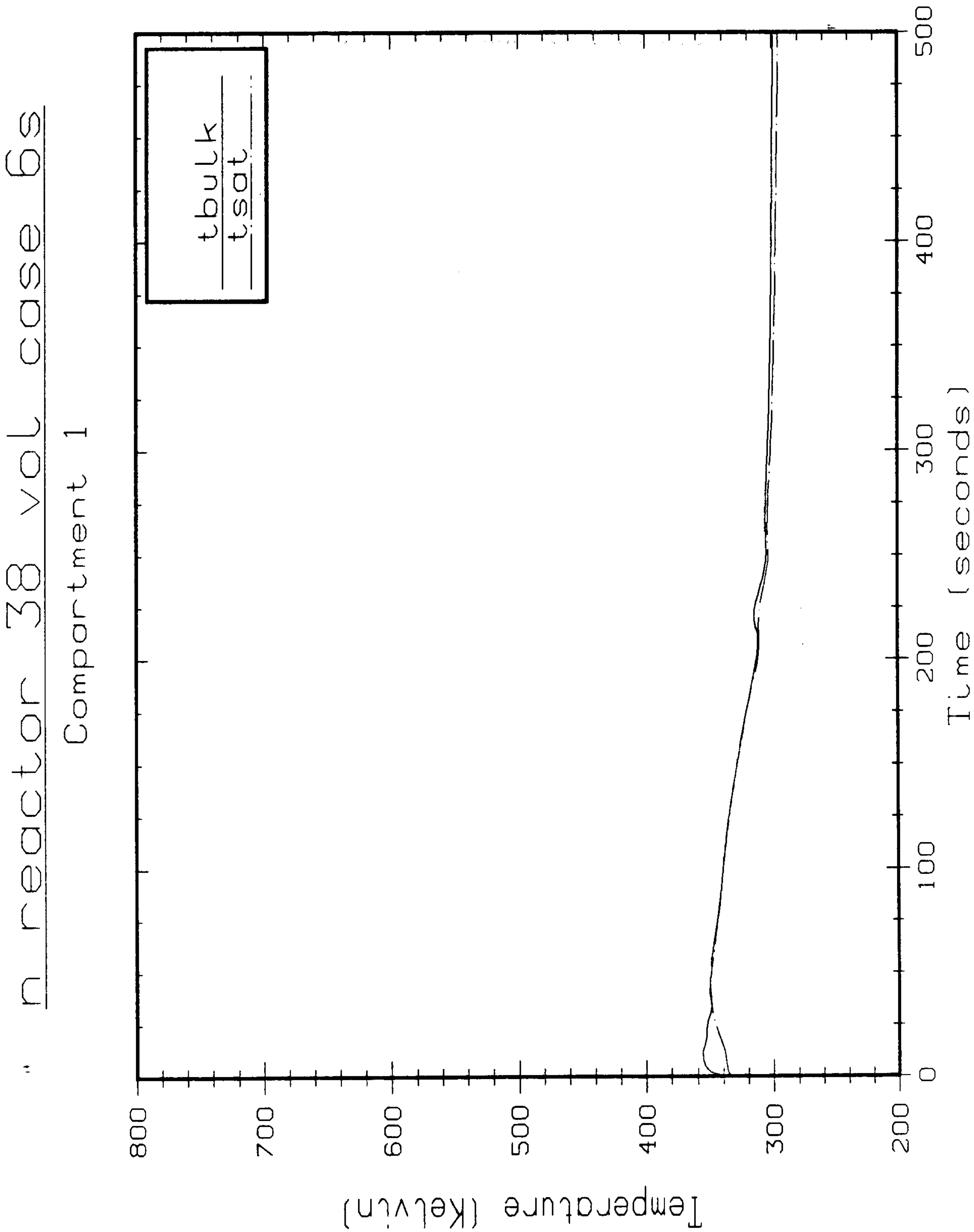

n reactor 38 vol case 5
Junction 42
Volumetric Flow Rate (m**3/sec)
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

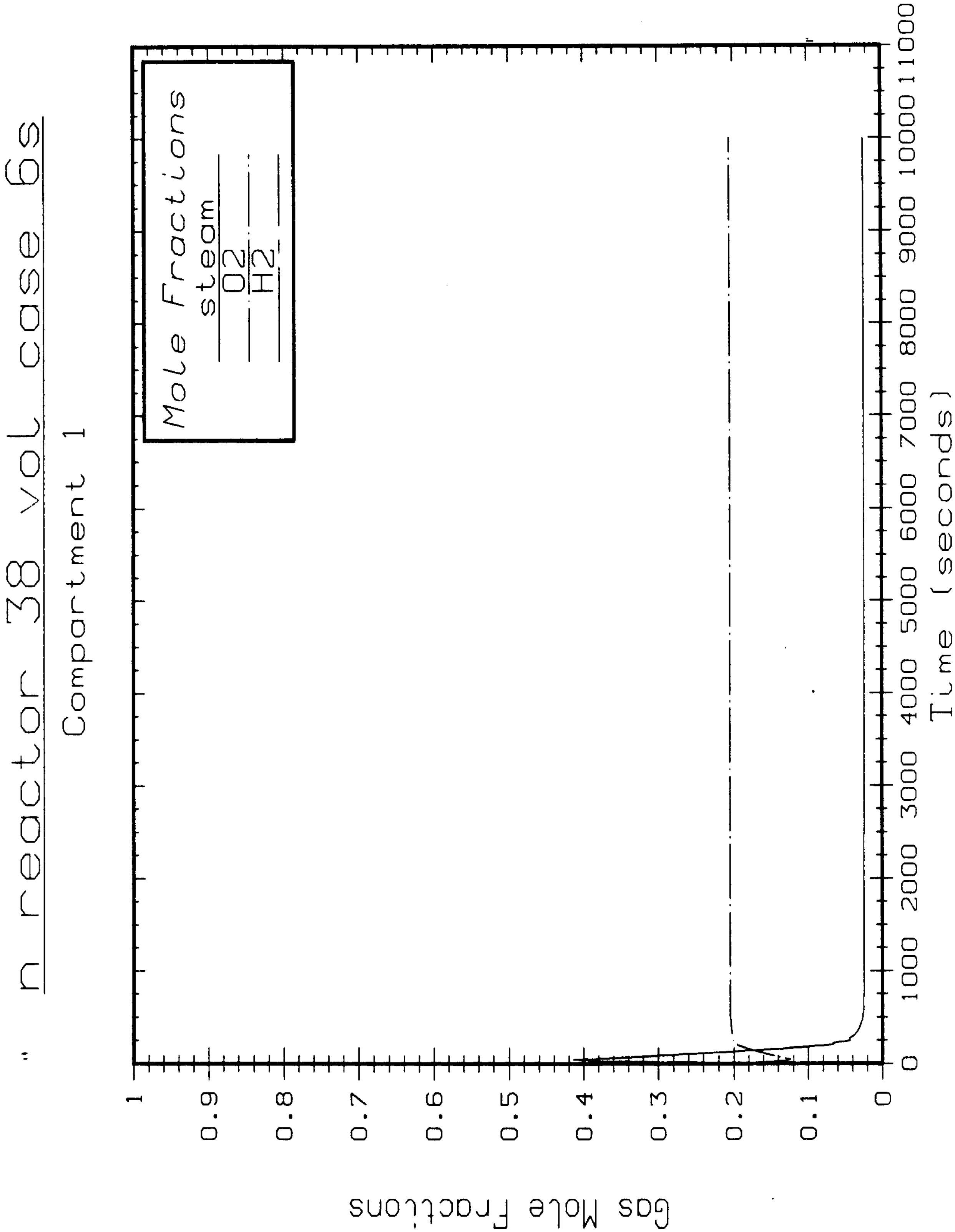

n reactor 38 vol case 5
Leakage from Leak 1
Total Gas Leaked (kg)
5000
0
-5000
-10000
-15000
-20000
-25000
-30000
-35000
-40000
-45000
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

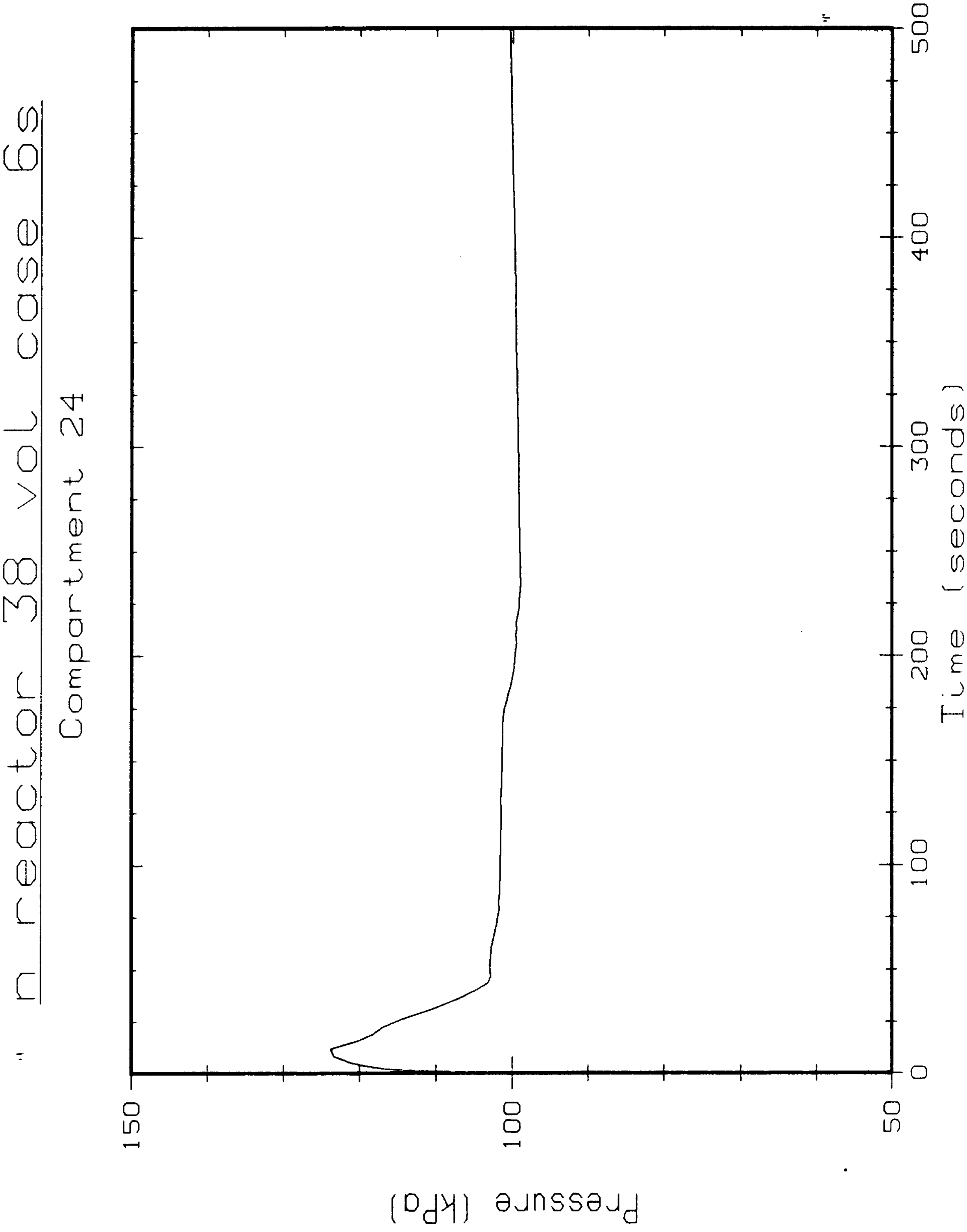
SELECTED PLOTS

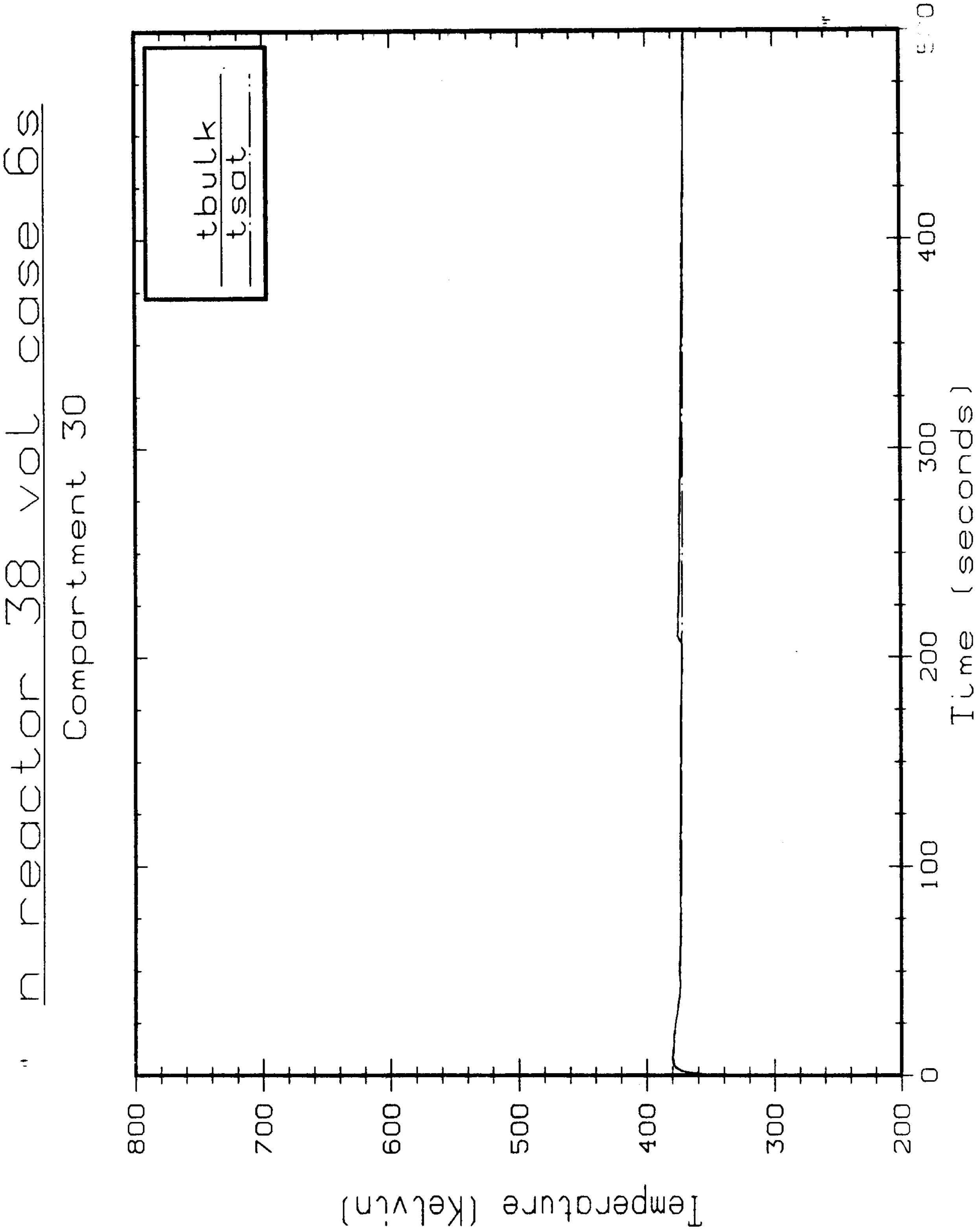
CASE 6S

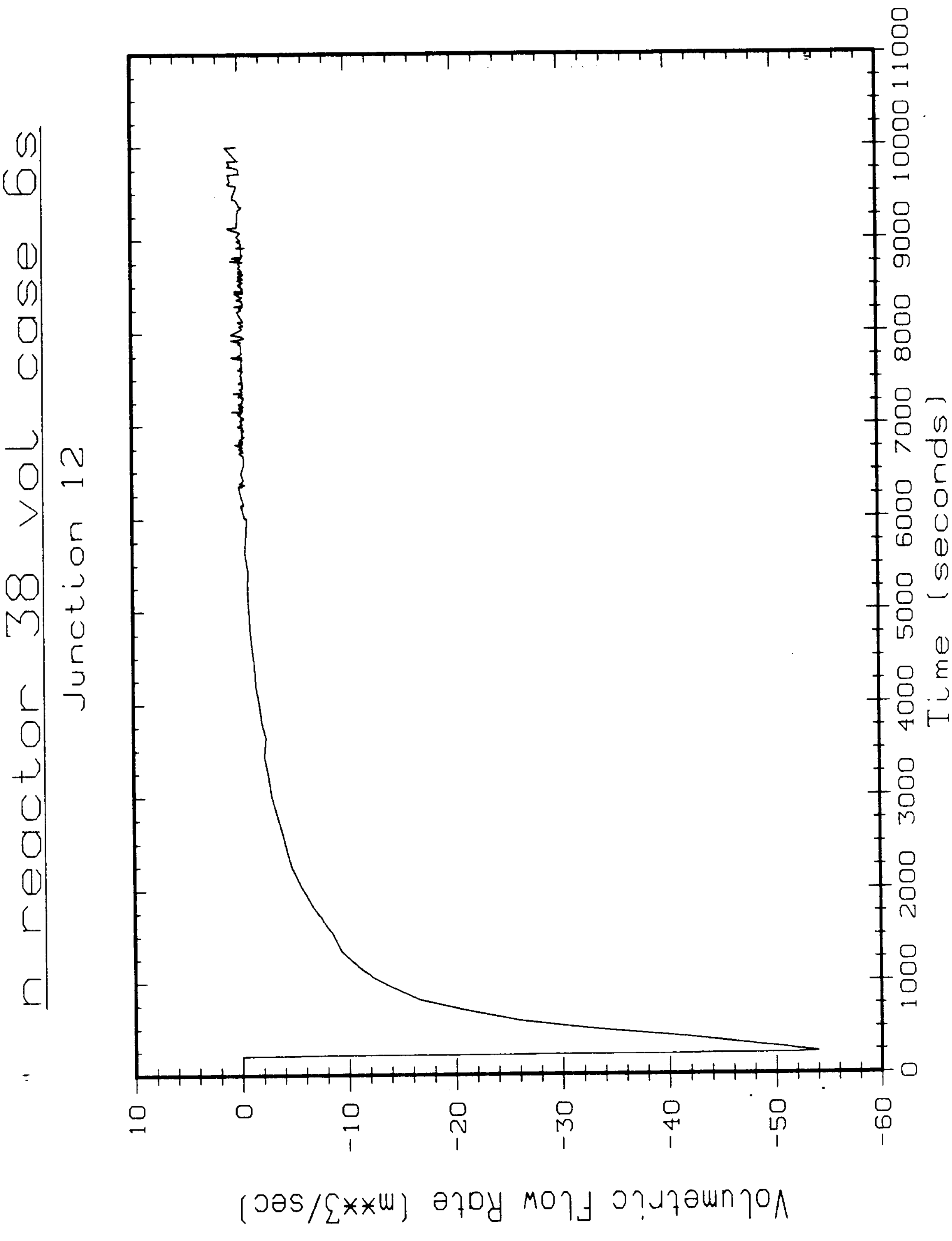

n reactor 38 vol case 6s
Compartment 1
Time (seconds)
0
100
200
300
400
500
Pressure (kPa)
50
100
150

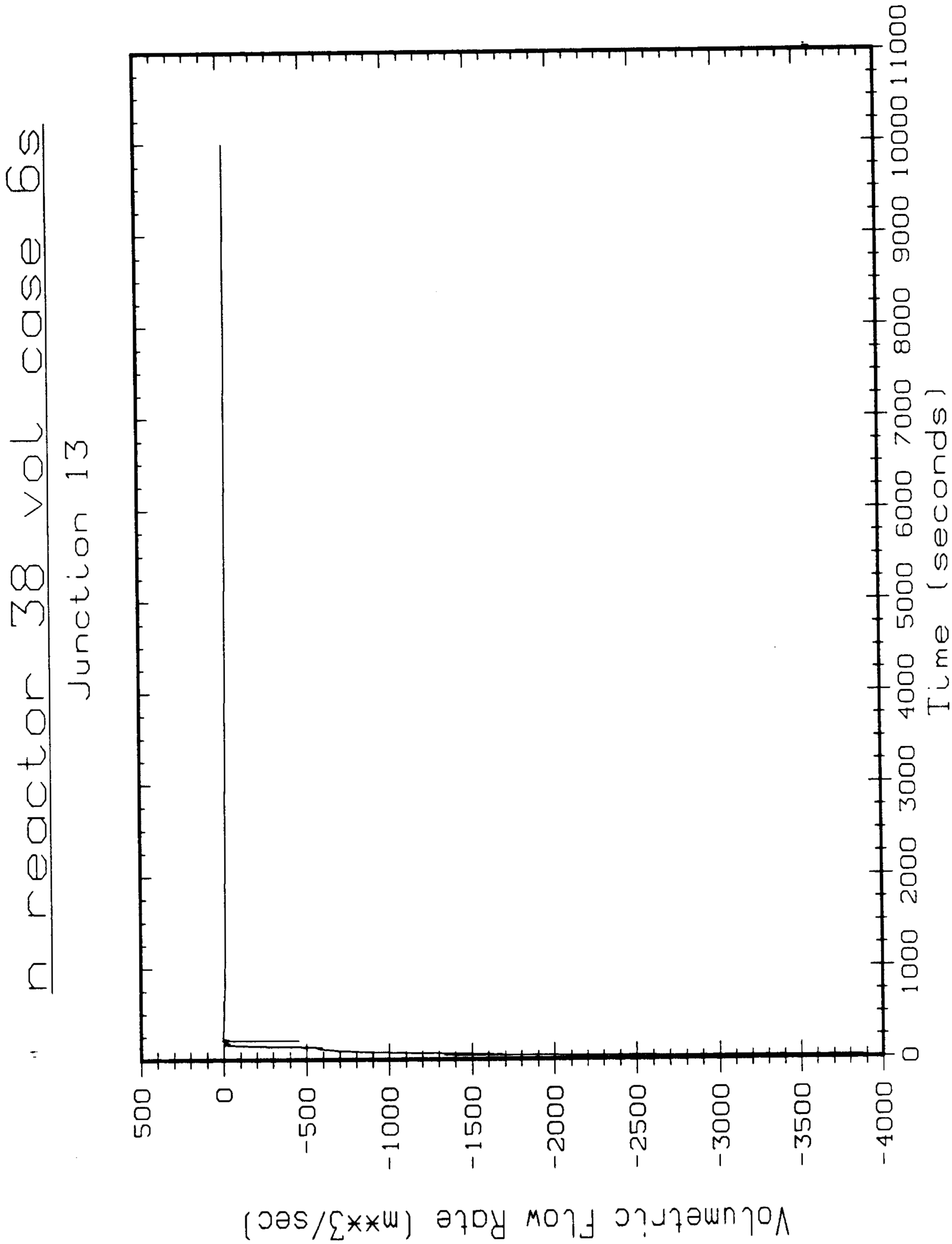

n reactor 38 vol case 6s
Compartment 1
tbulk
tsat
Temperature (Kelvin)
800
700
600
500
400
300
200
Time (seconds)
0
100
200
300
400
500

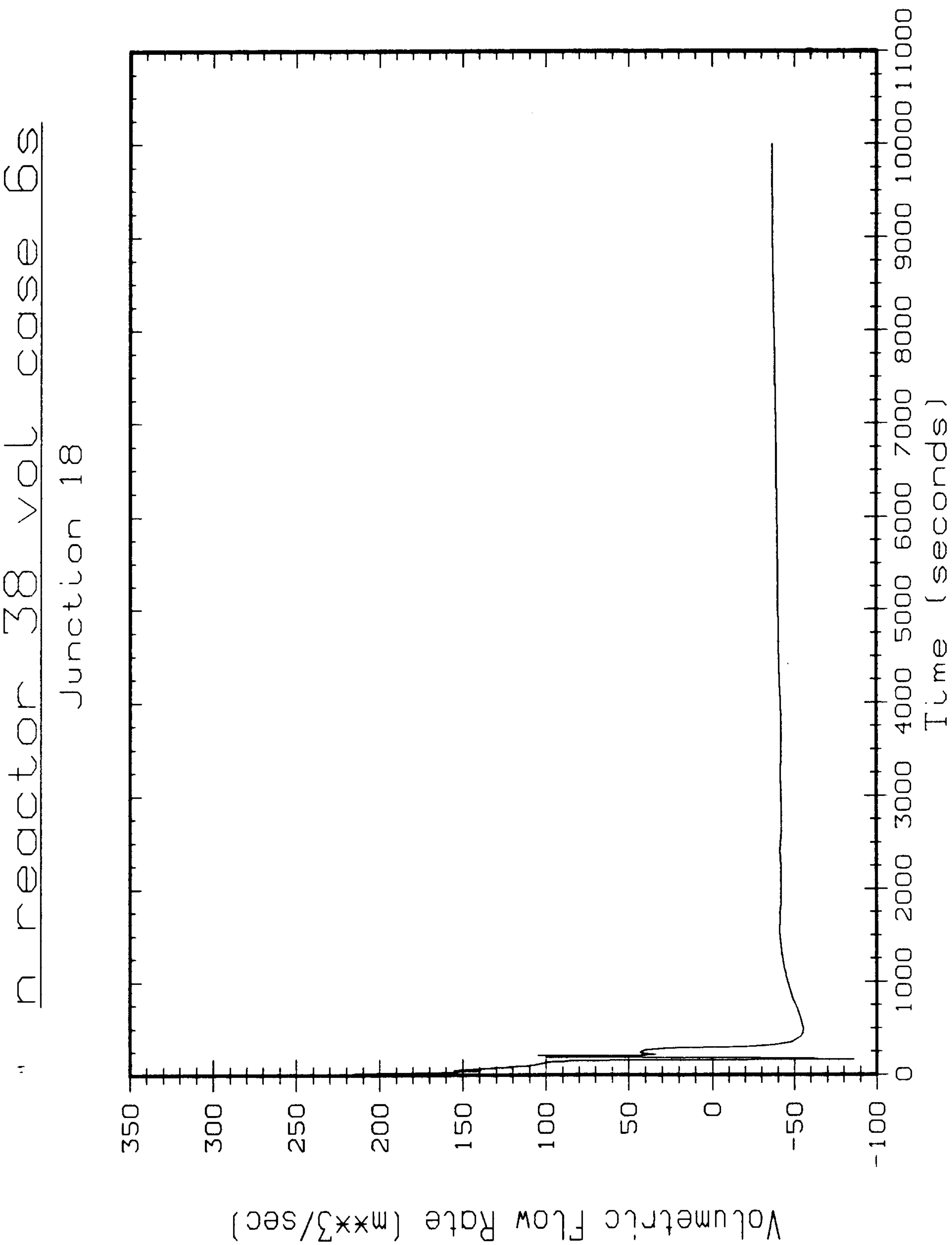

n reactor 38 vol case 6s
Compartment 1
Mole Fractions
steam
O2
H2
Time (seconds)
Gas Mole Fractions
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

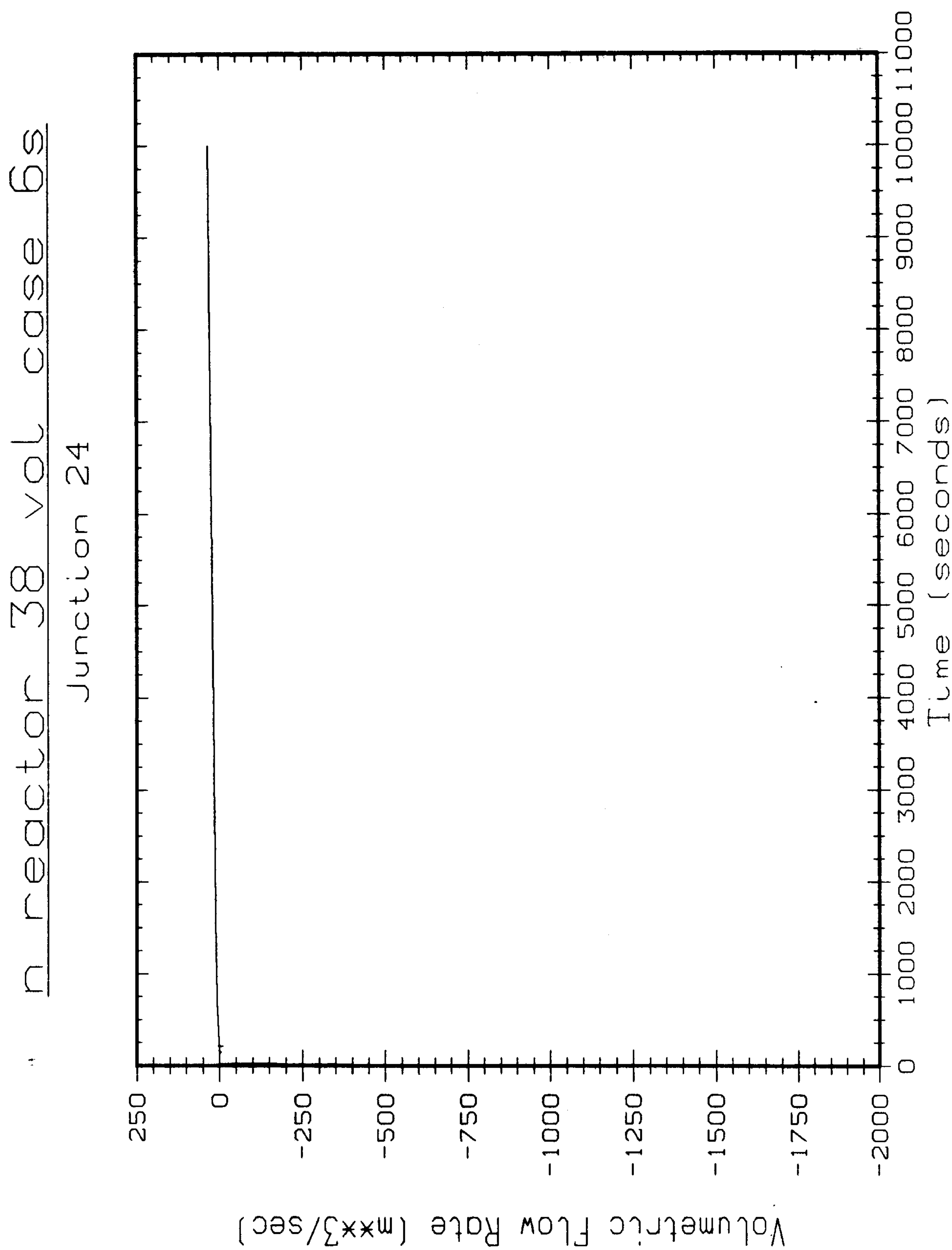

n reactor 38 vol case 6s
Compartment 24
Pressure (kPa)
Time (seconds)
150
100
50
0
100
200
300
400
500


n reactor 38 vol case 6s
Compartment 30
tbulk
tsat
Temperature (Kelvin)
800
700
600
500
400
300
200
Time (seconds)
0
100
200
300
400


n reactor 38 vol case 6s
Junction 12
Volumetric Flow Rate (m**3/sec)
Time (seconds)
10
0
-10
-20
-30
-40
-50
-60
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000


n reactor 38 vol case 6s
Junction 13
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
Volumetric Flow Rate (m**3/sec)
500
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000

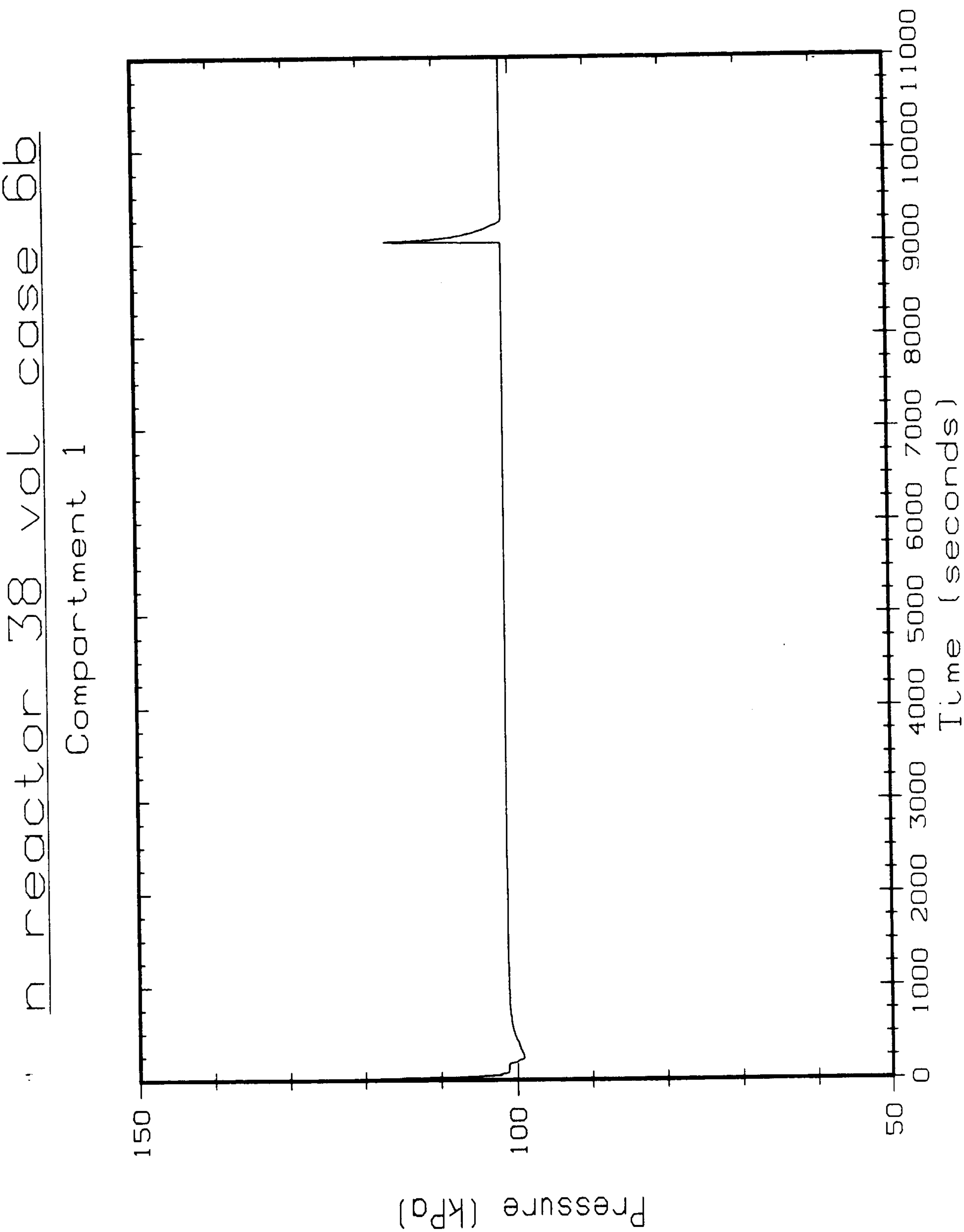

n reactor 38 vol case 6s
Junction 18
Time (seconds)
Volumetric Flow Rate (m**3/sec)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
350
300
250
200
150
100
50
0
-50
-100

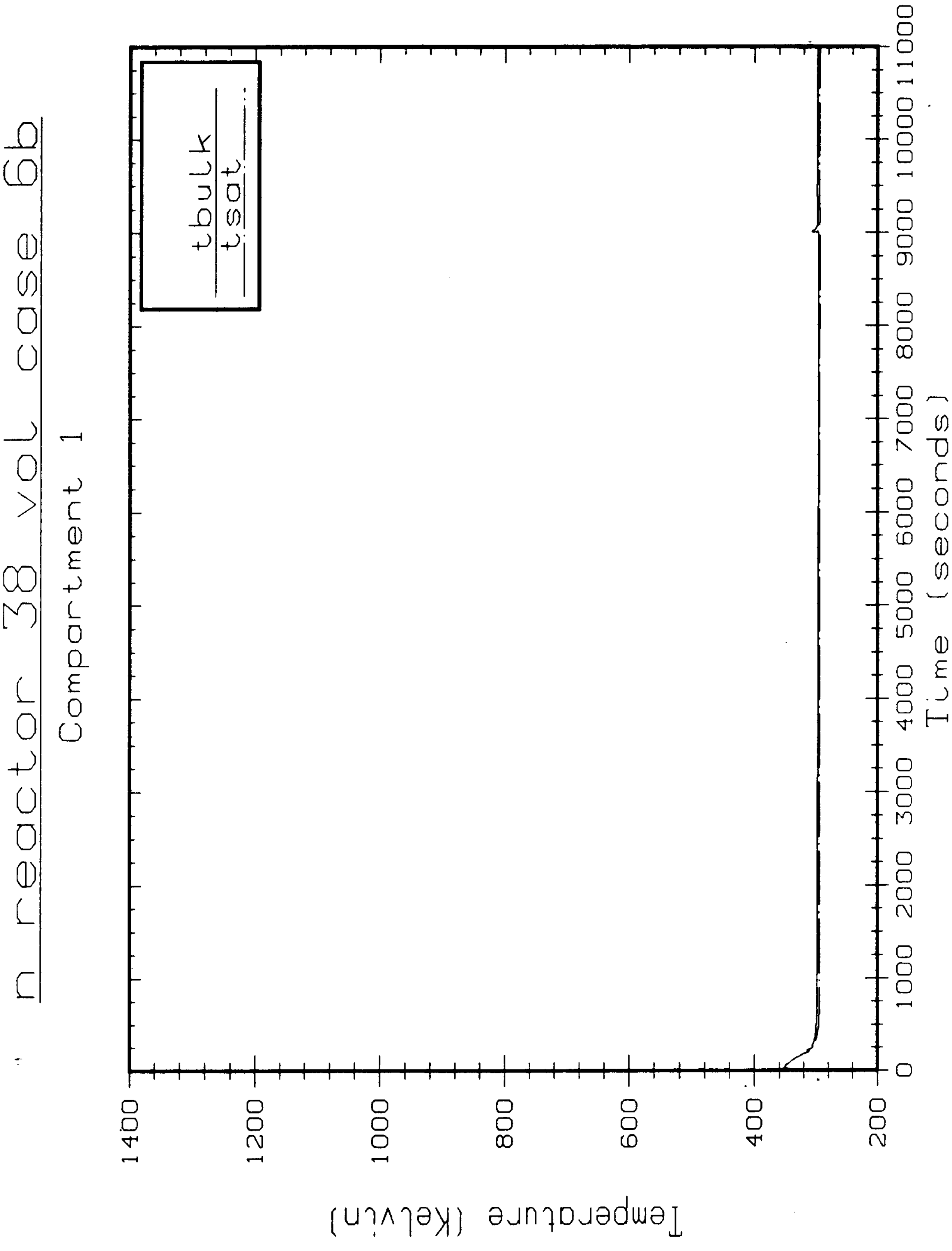


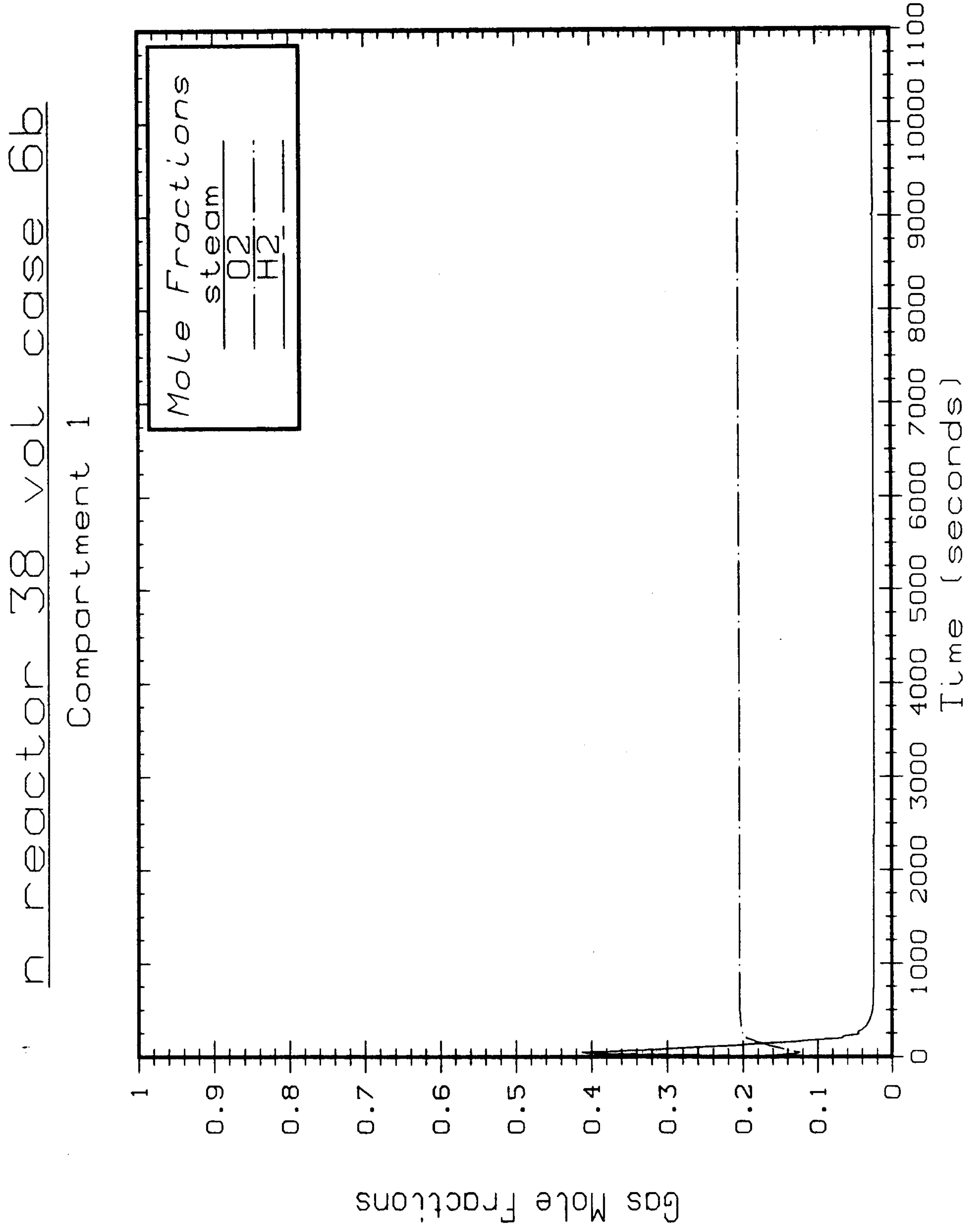
n reactor 38 vol case 6s
Junction 24
Volumetric Flow Rate (m**3/sec)
250
0
-250
-500
-750
-1000
-1250
-1500
-1750
-2000
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

SELECTED PLOTS

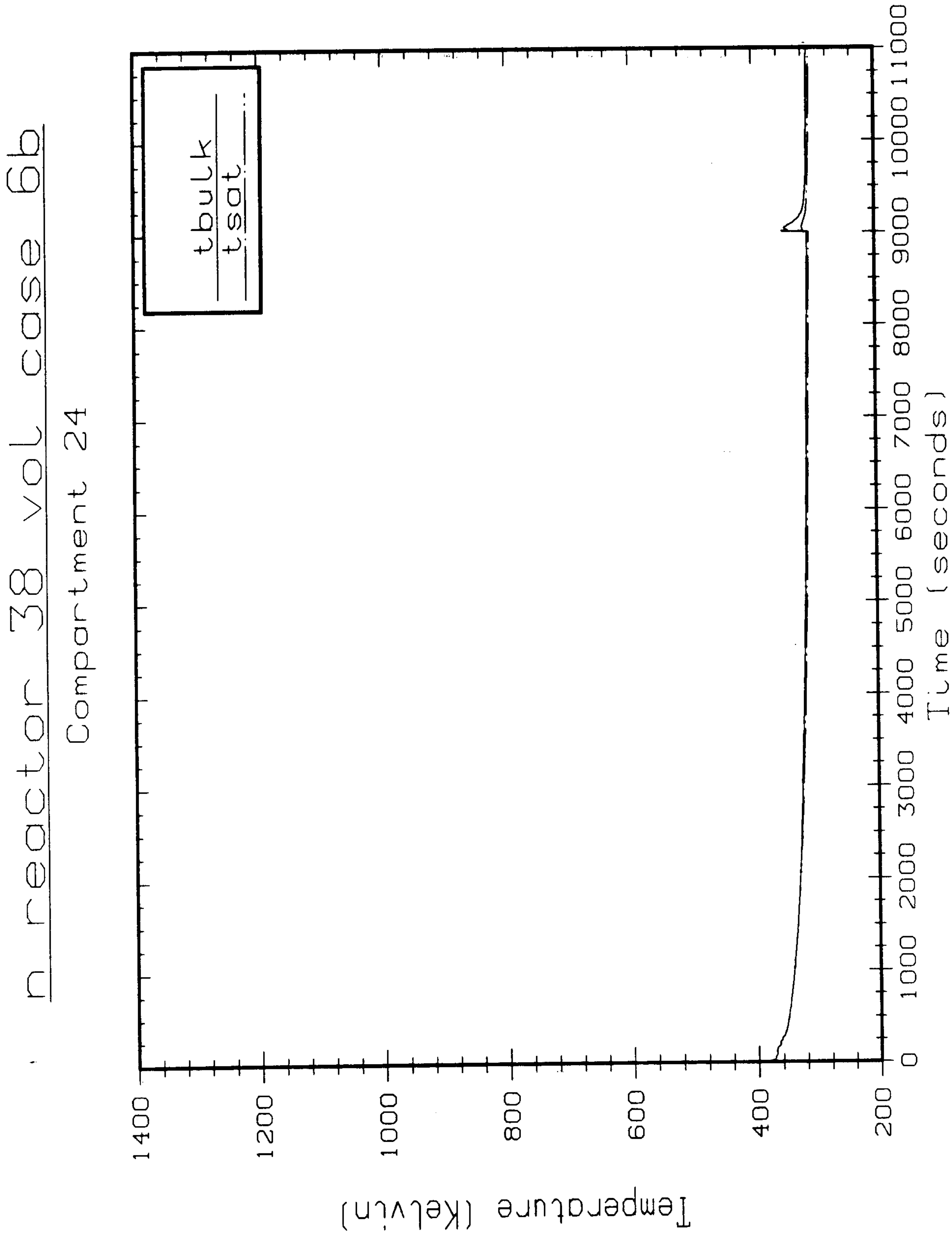
CASE 6B

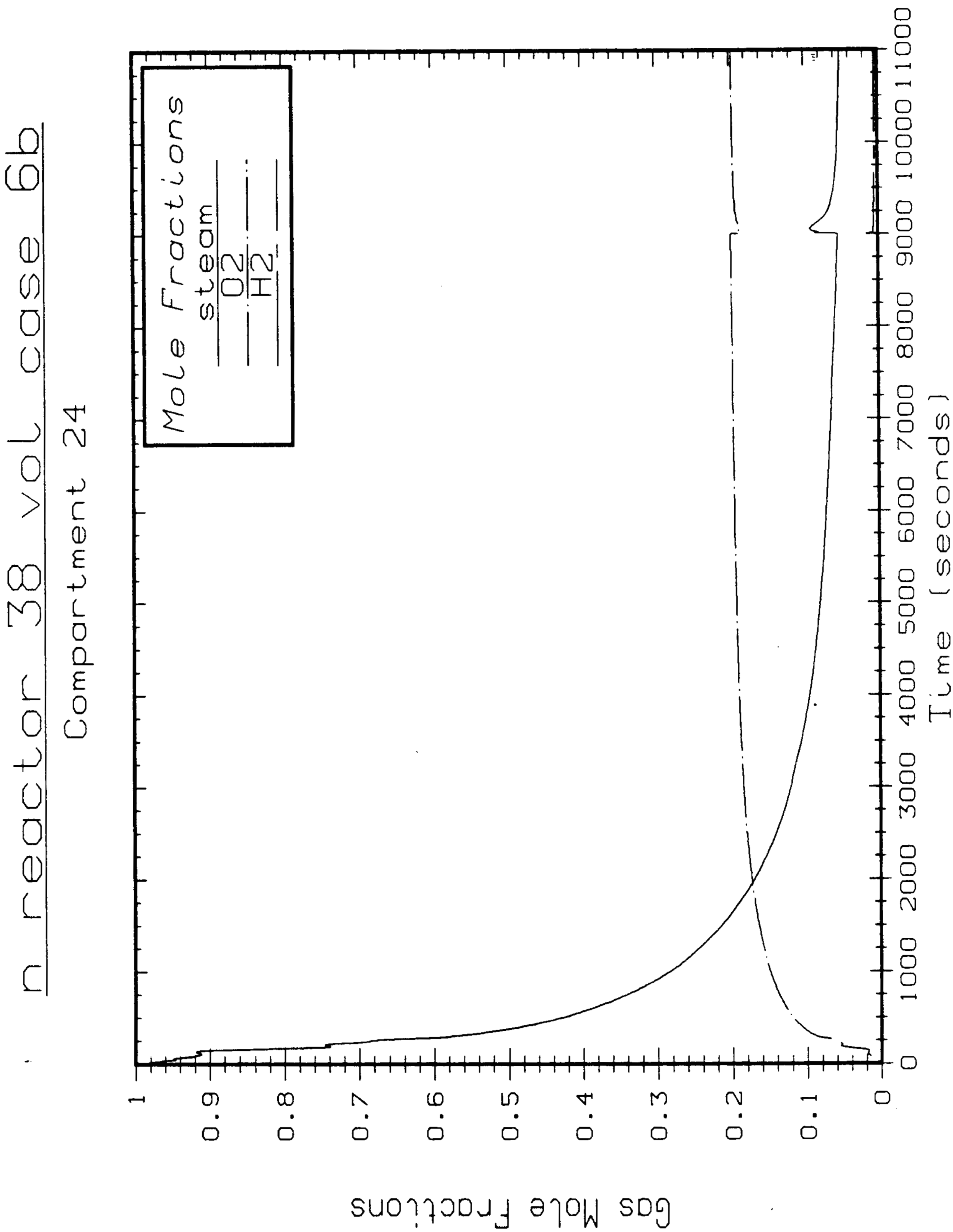

n reactor 38 vol case 6b
Compartment 1
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
Pressure (kPa)
150
100
50

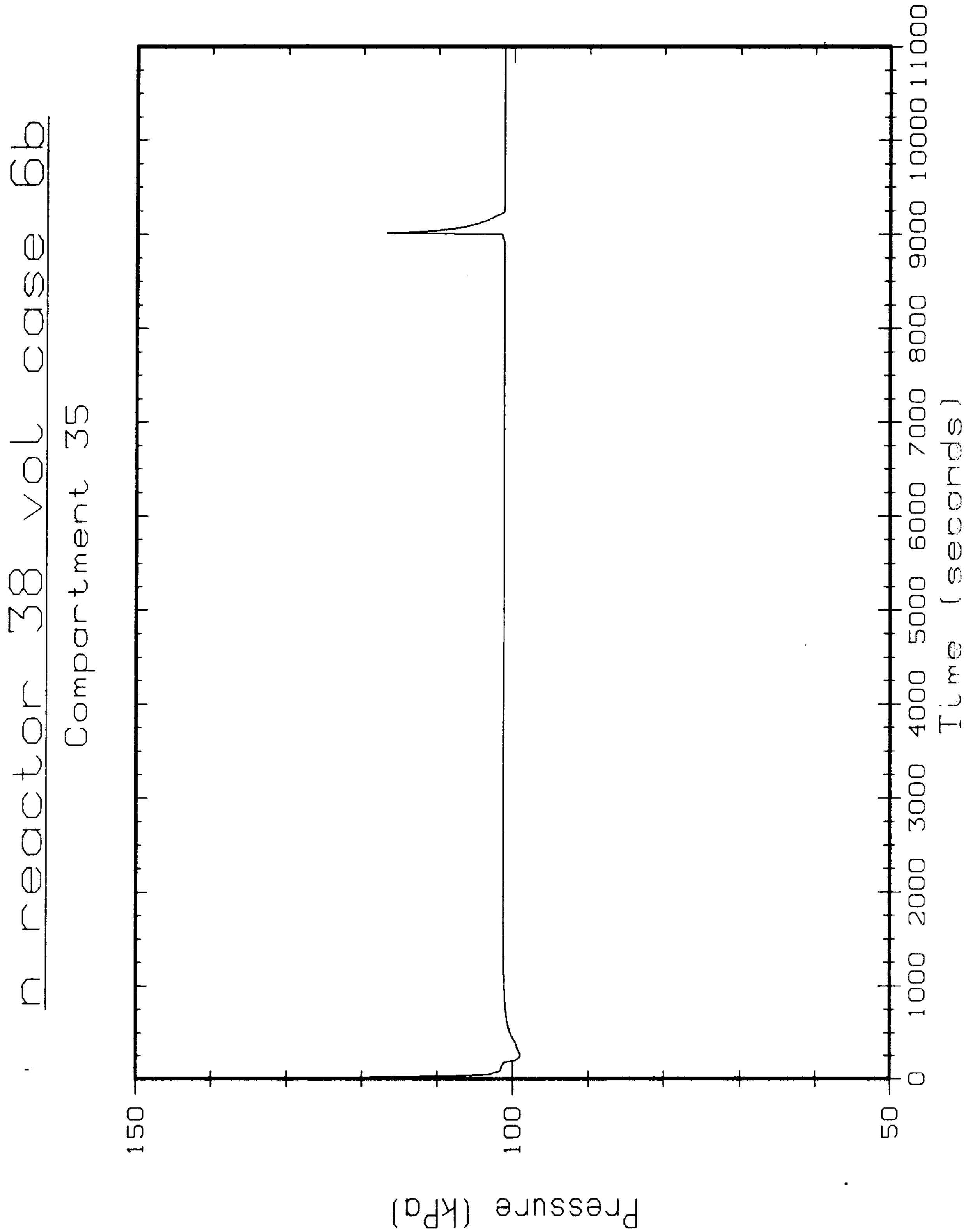

n reactor 38 vol case 6b
Compartment 1
tbulk
tsat
Temperature (Kelvin)
Time (seconds)
1400
1200
1000
800
600
400
200
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

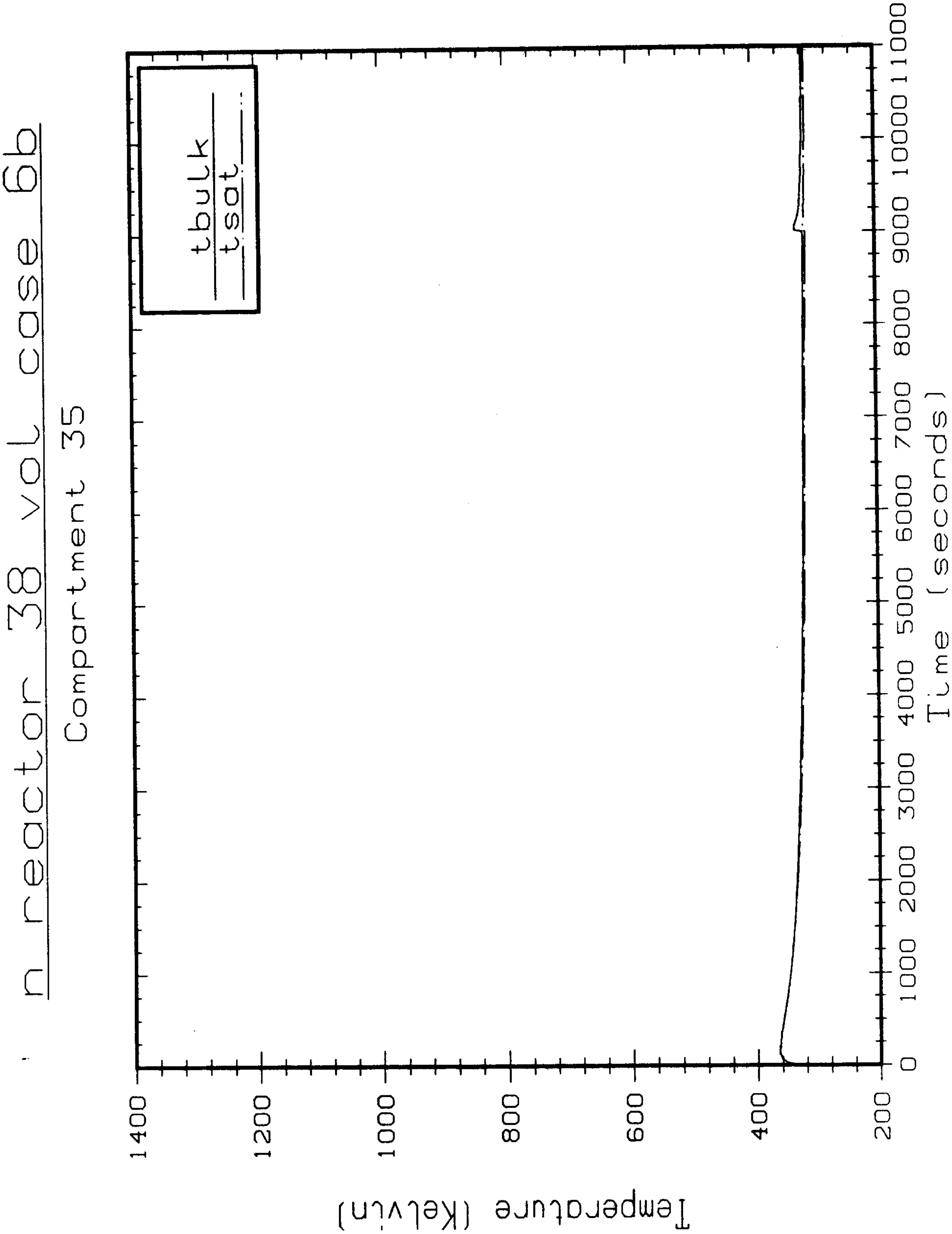


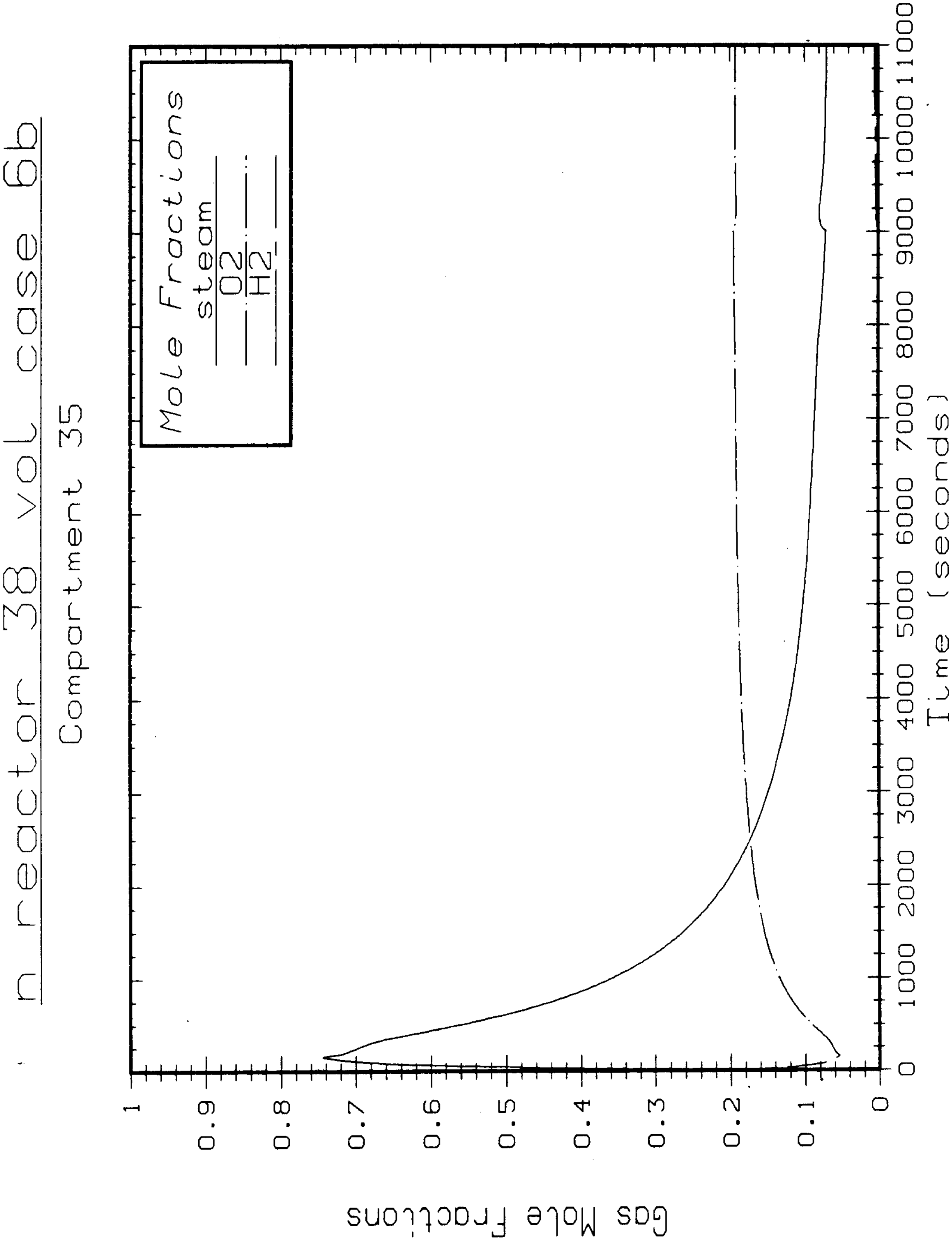
n reactor 38 vol case 6b
Compartment 1
Mole Fractions
steam
O2
H2
Time (seconds)
Gas Mole Fractions
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

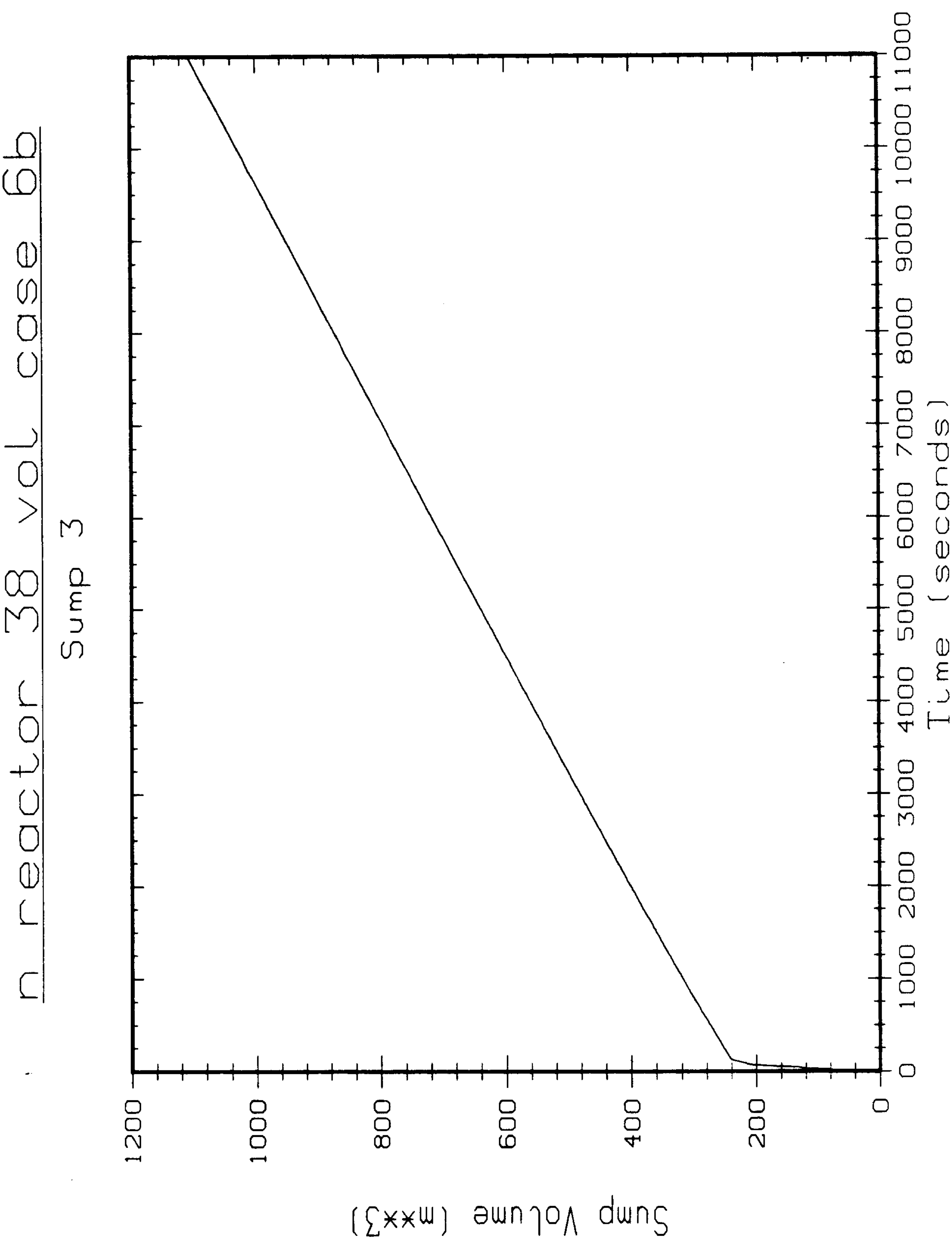

n reactor 38 vol case 6b
Compartment 24
tbulk
tsat
Time (seconds)
0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000
Temperature (Kelvin)
200 400 600 800 1000 1200 1400

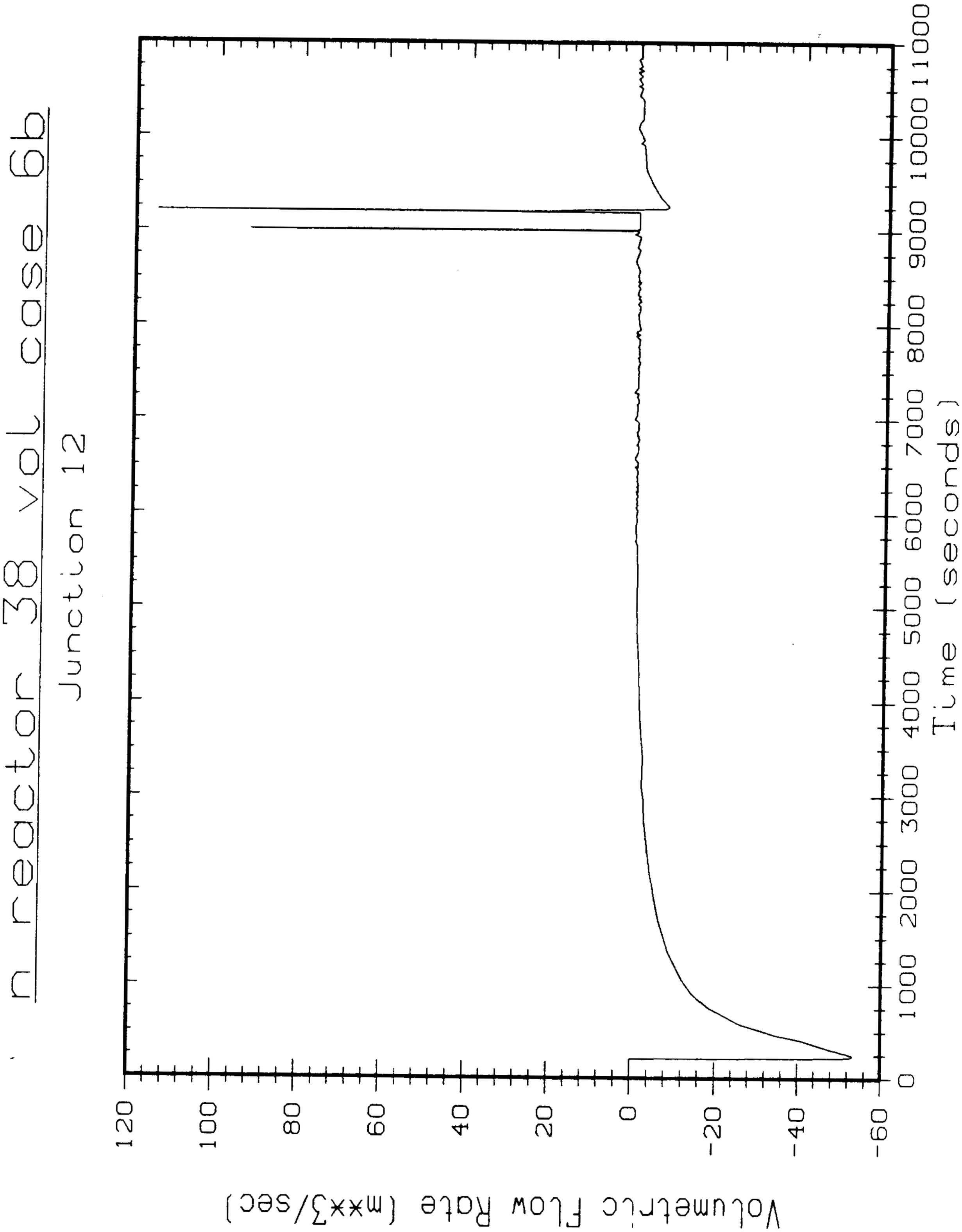

n reactor 38 vol case 6b
Compartment 24
Mole Fractions
steam
O2
H2
Gas Mole Fractions
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

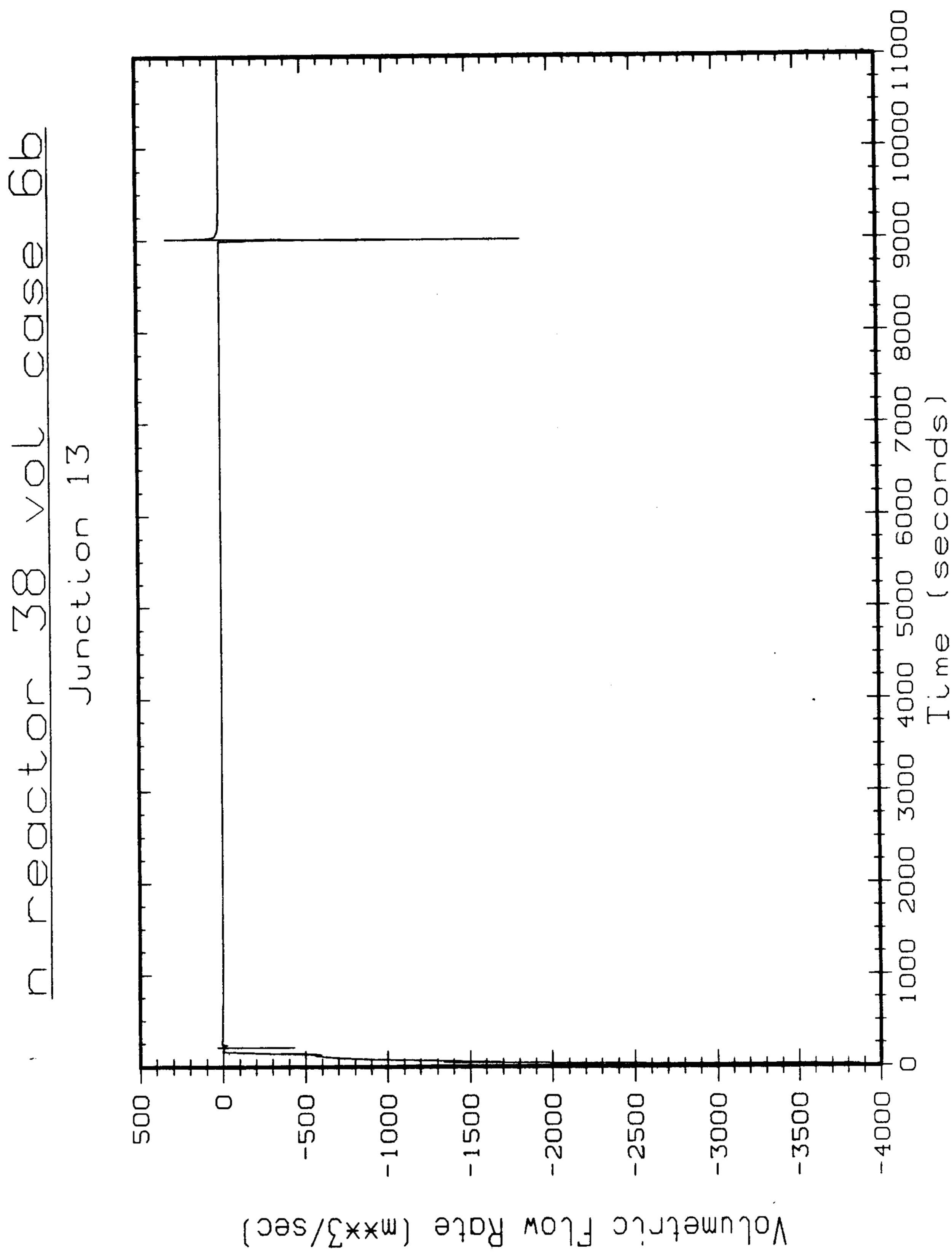

n reactor 38 vol case 6b
Compartment 35
Time (seconds)
Pressure (kPa)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
150
100
50

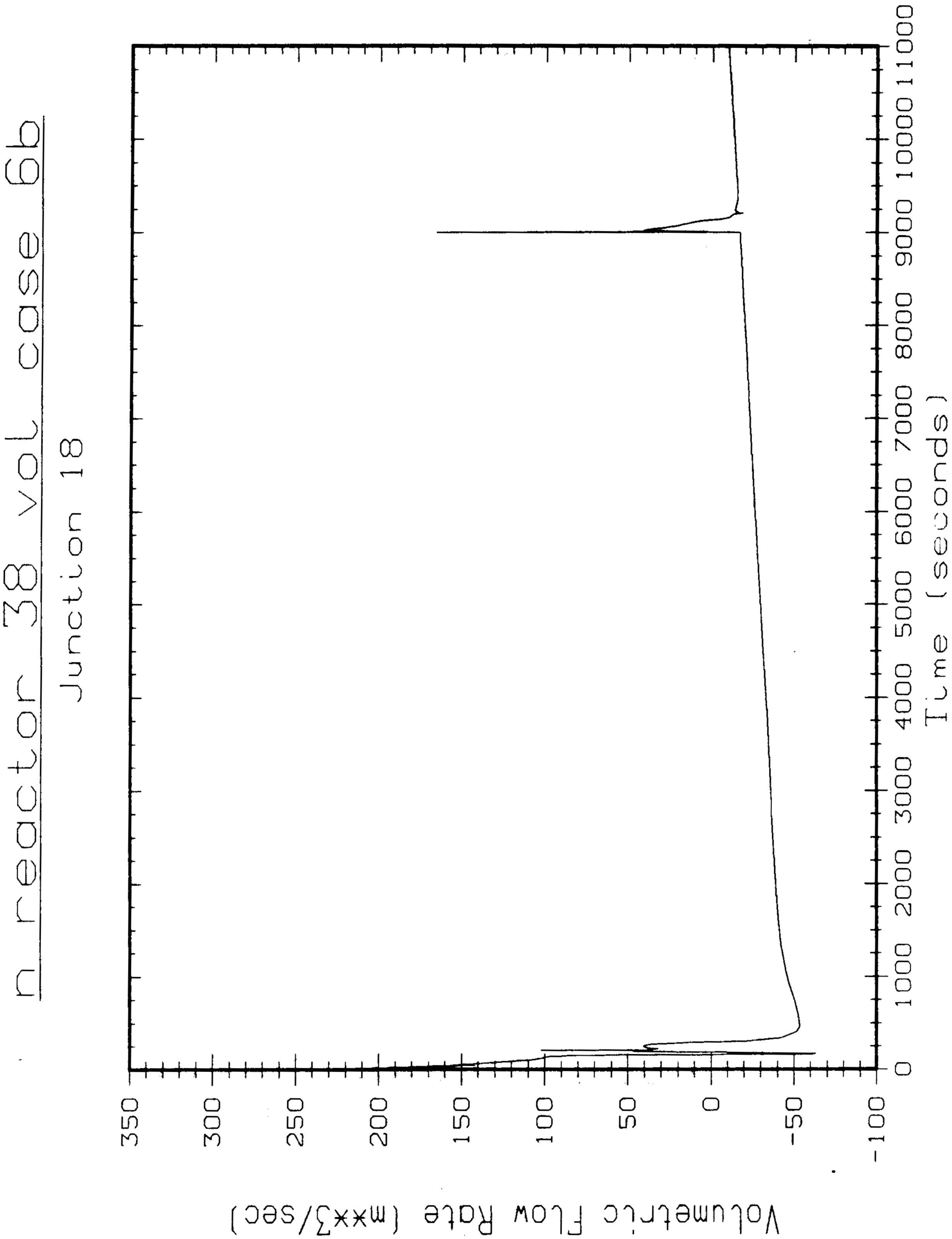

n reactor 38 vol case 6b
Compartment 35
tbulk
tsat
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
Temperature (Kelvin)
200
400
600
800
1000
1200
1400


n reactor 38 vol case 6b
Compartment 35
Mole Fractions
steam
O2
H2
Time (seconds)
Gas Mole Fractions
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


n reactor 38 vol case 6b
Sump 3
Sump Volume (m**3)
0
200
400
600
800
1000
1200
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

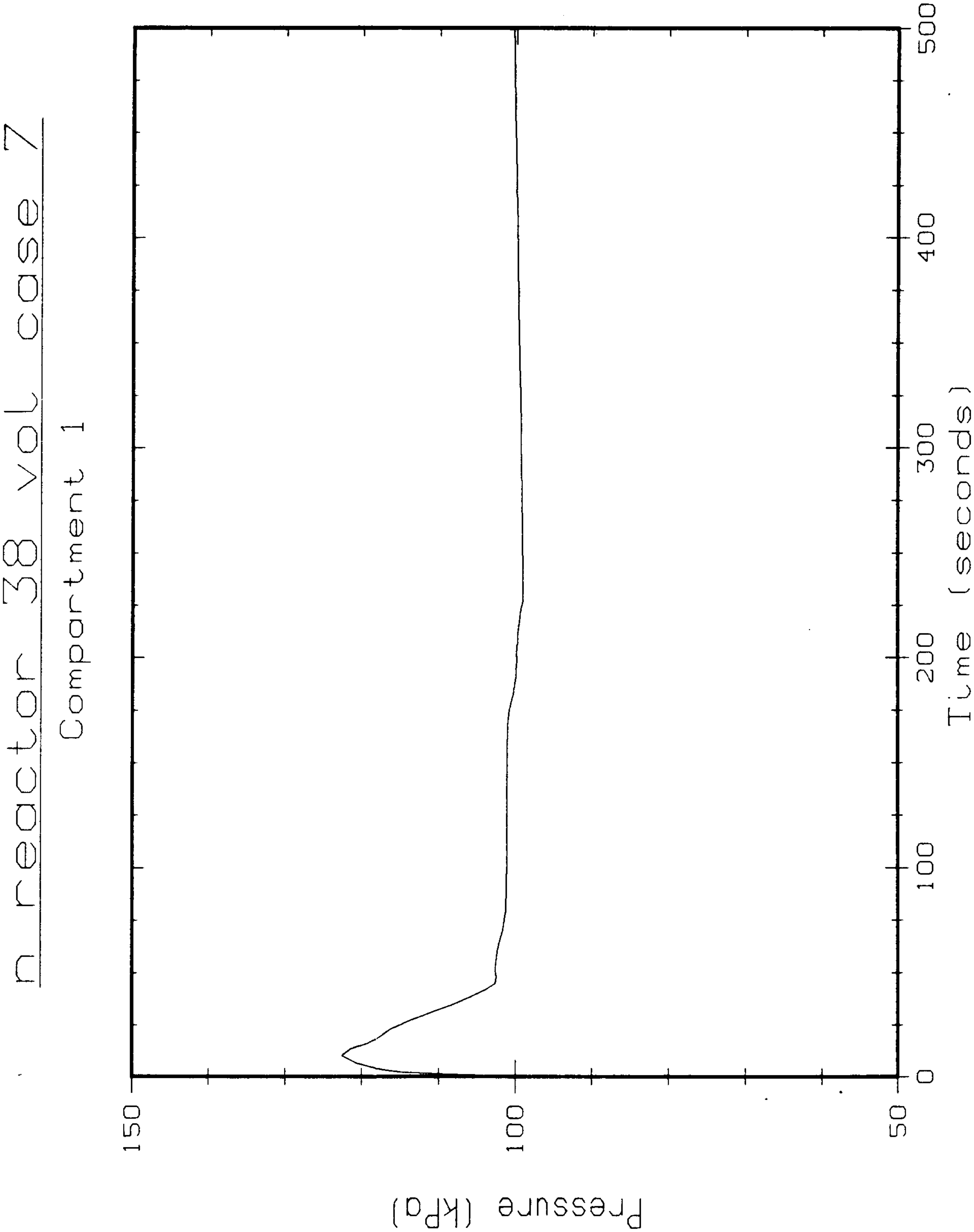

n reactor 38 vol case 6b
Junction 12
Time (seconds)
Volumetric Flow Rate (m**3/sec)
0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000
120 100 80 60 40 20 0 -20 -40 -60

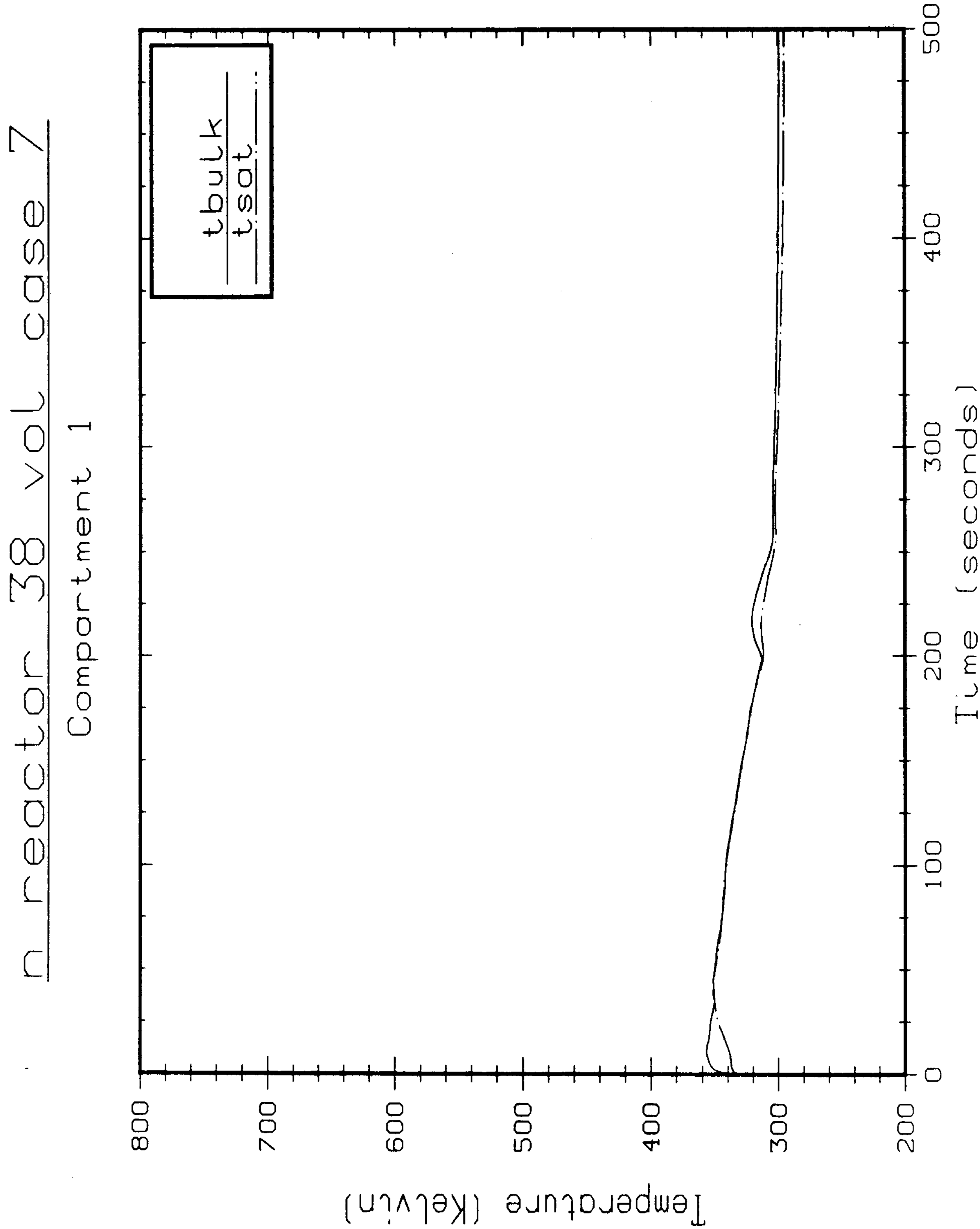

n reactor 38 vol case 6b
Junction 13
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
Volumetric Flow Rate (m**3/sec)
500
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000

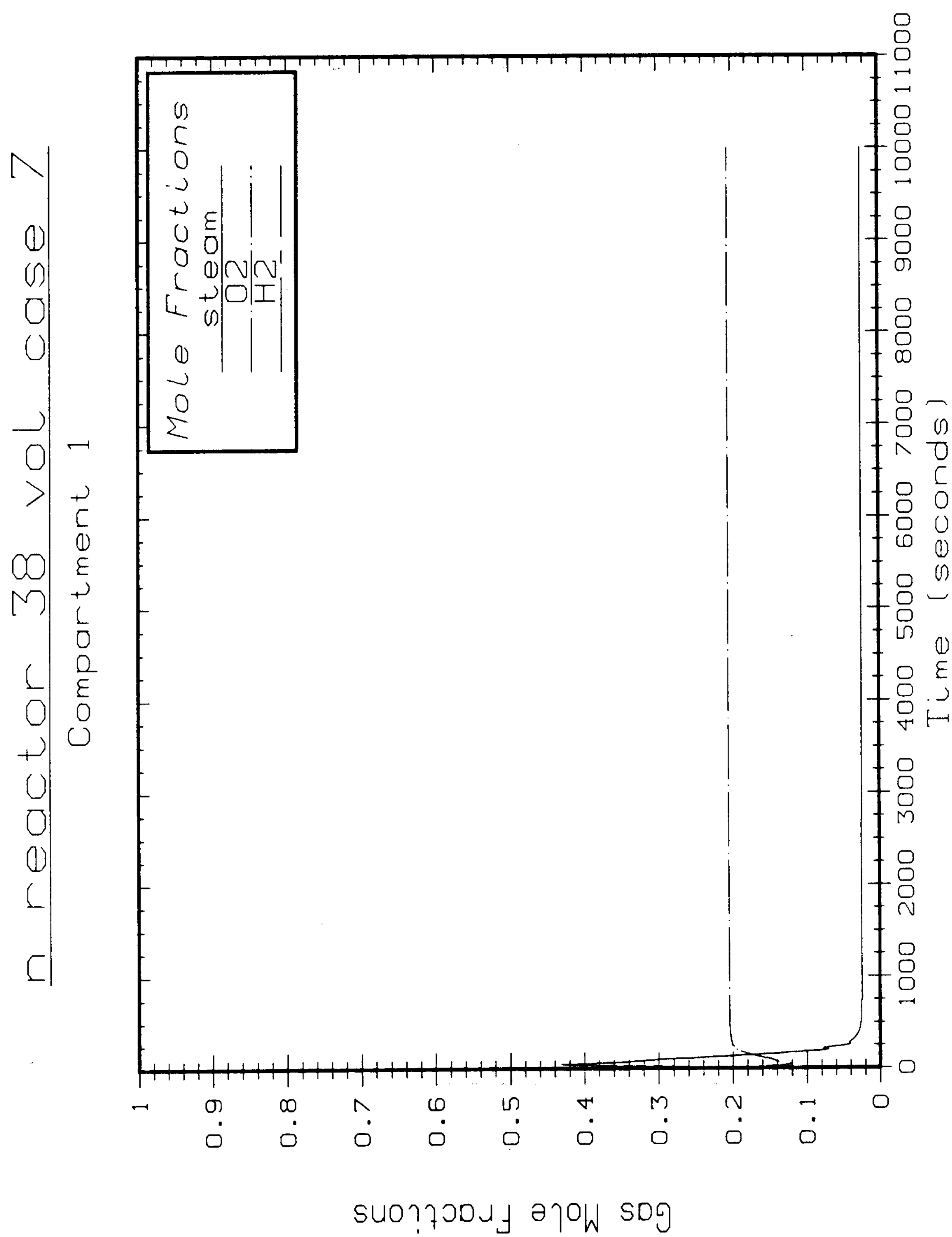

n reactor 38 vol case 6b
Junction 18
Time (seconds)
Volumetric Flow Rate (m**3/sec)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
350
300
250
200
150
100
50
0
-50
-100

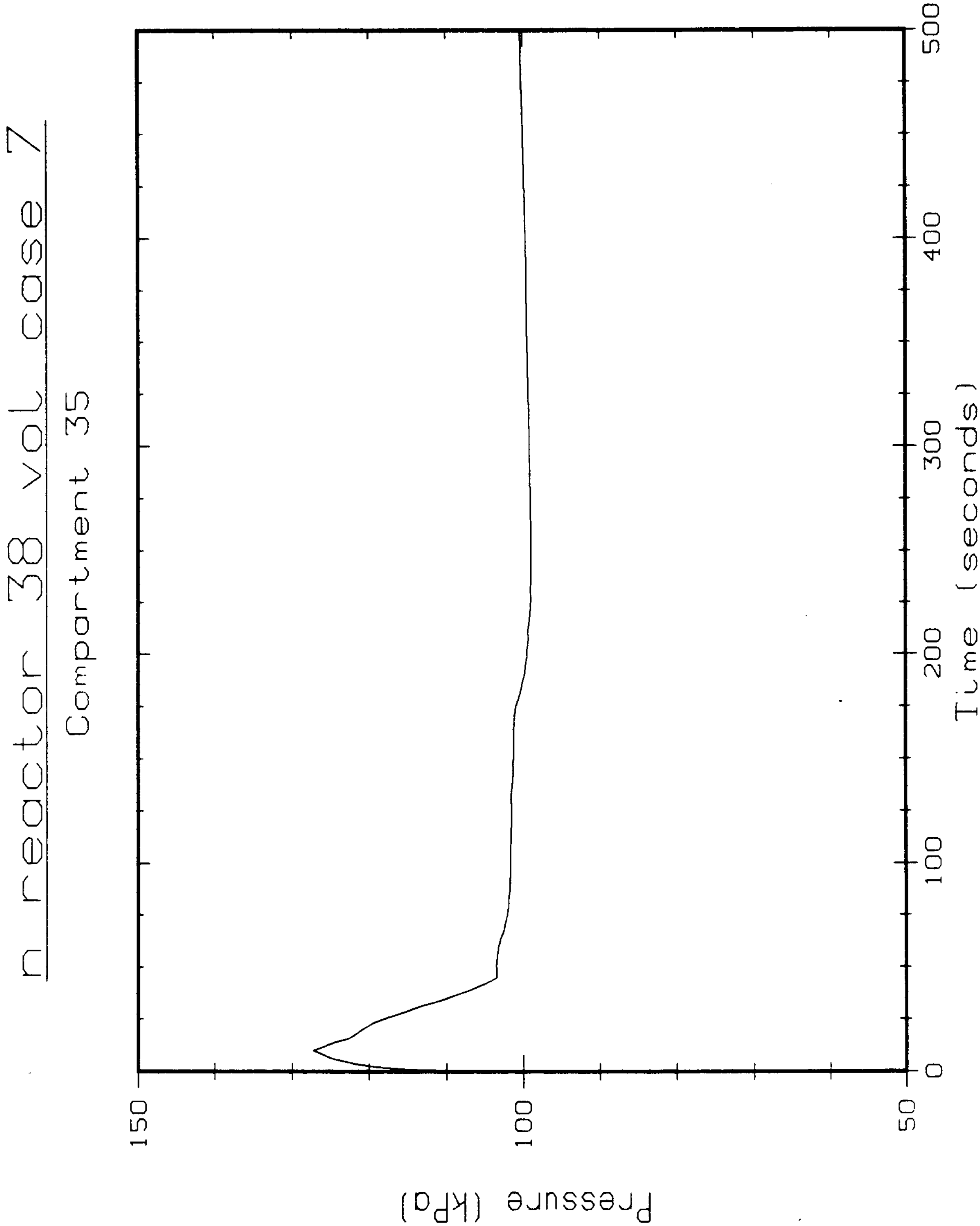
SELECTED PLOTS

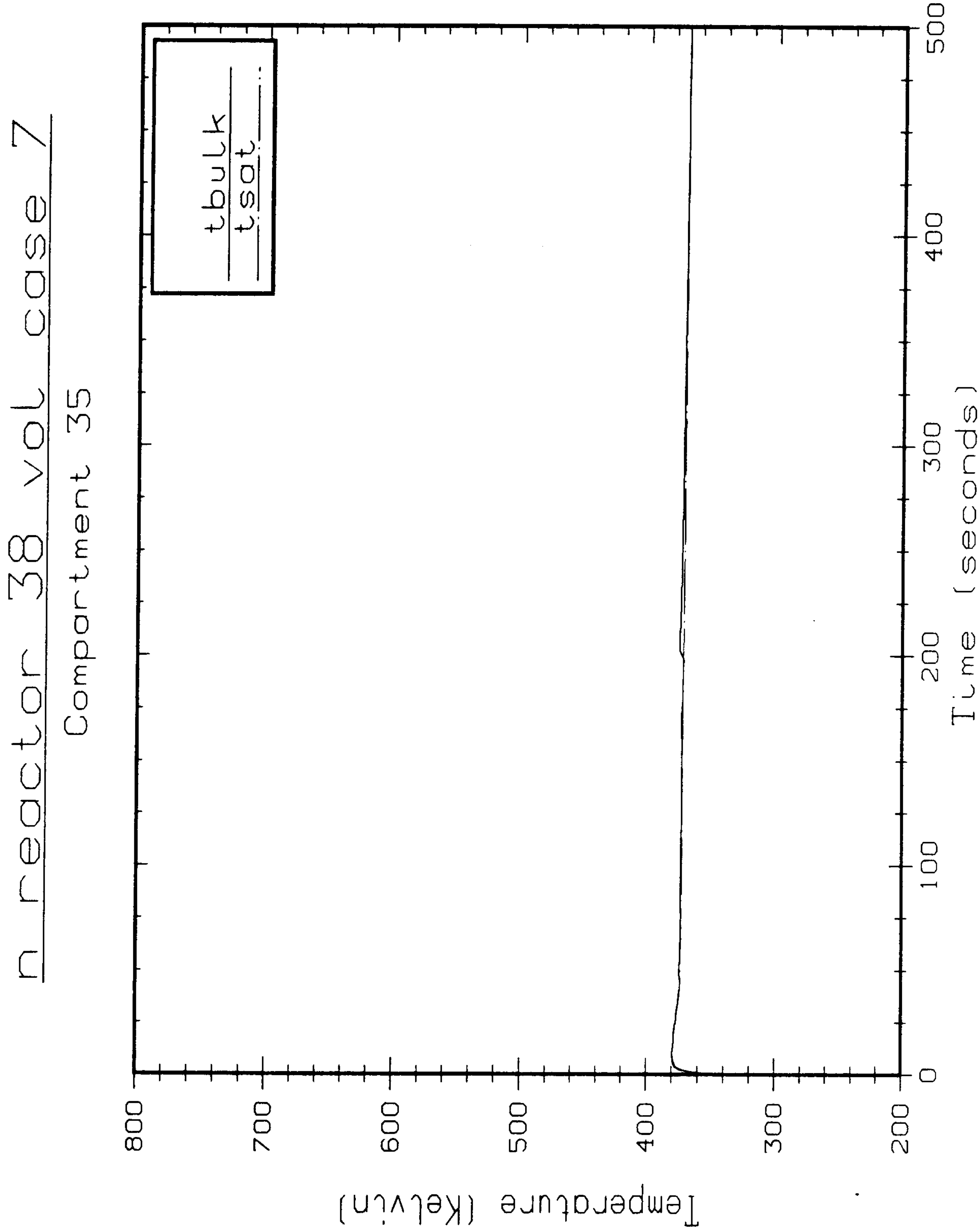
CASE 7

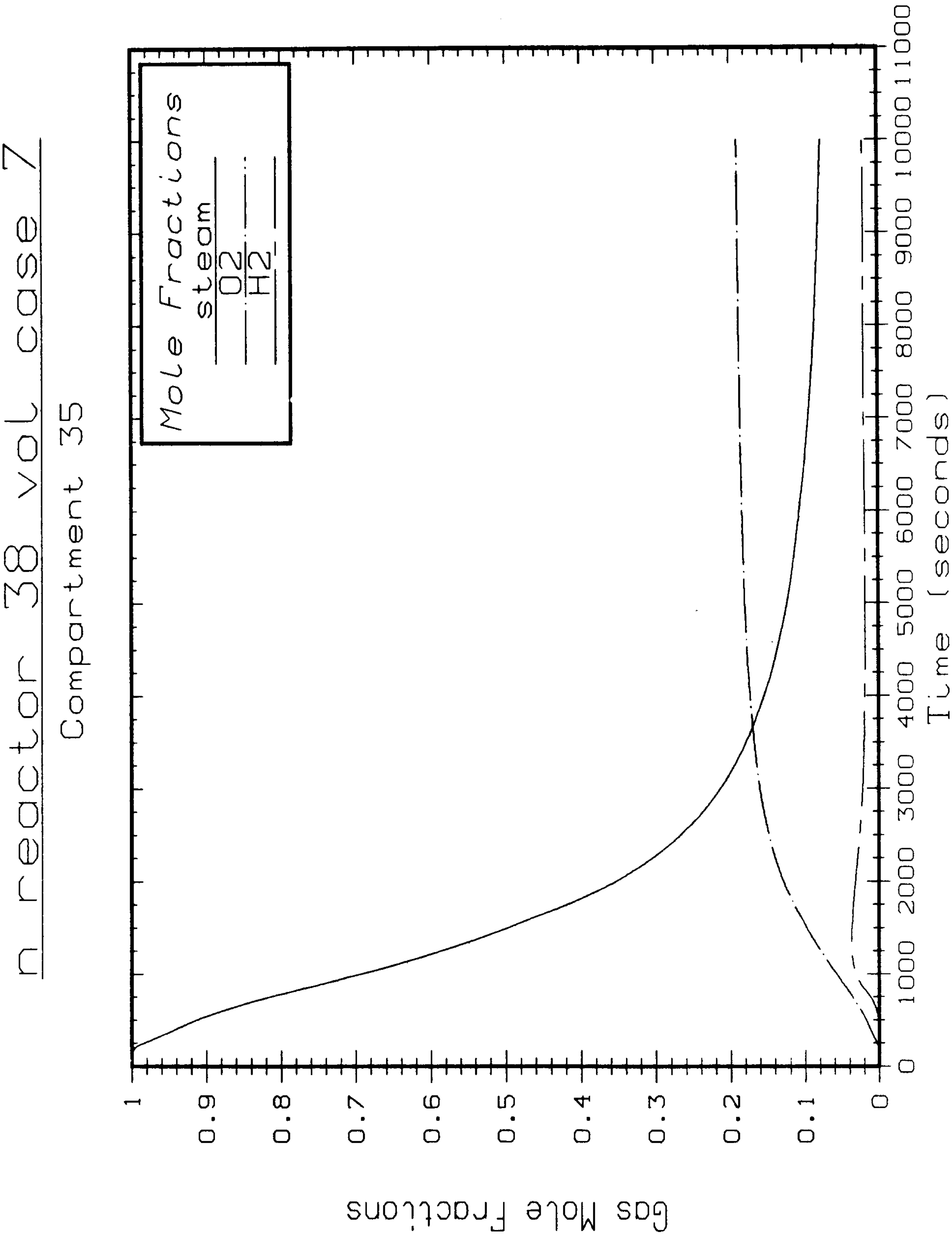

n reactor 38 vol case 7
Compartment 1
Pressure (kPa)
150
100
50
Time (seconds)
0
100
200
300
400
500

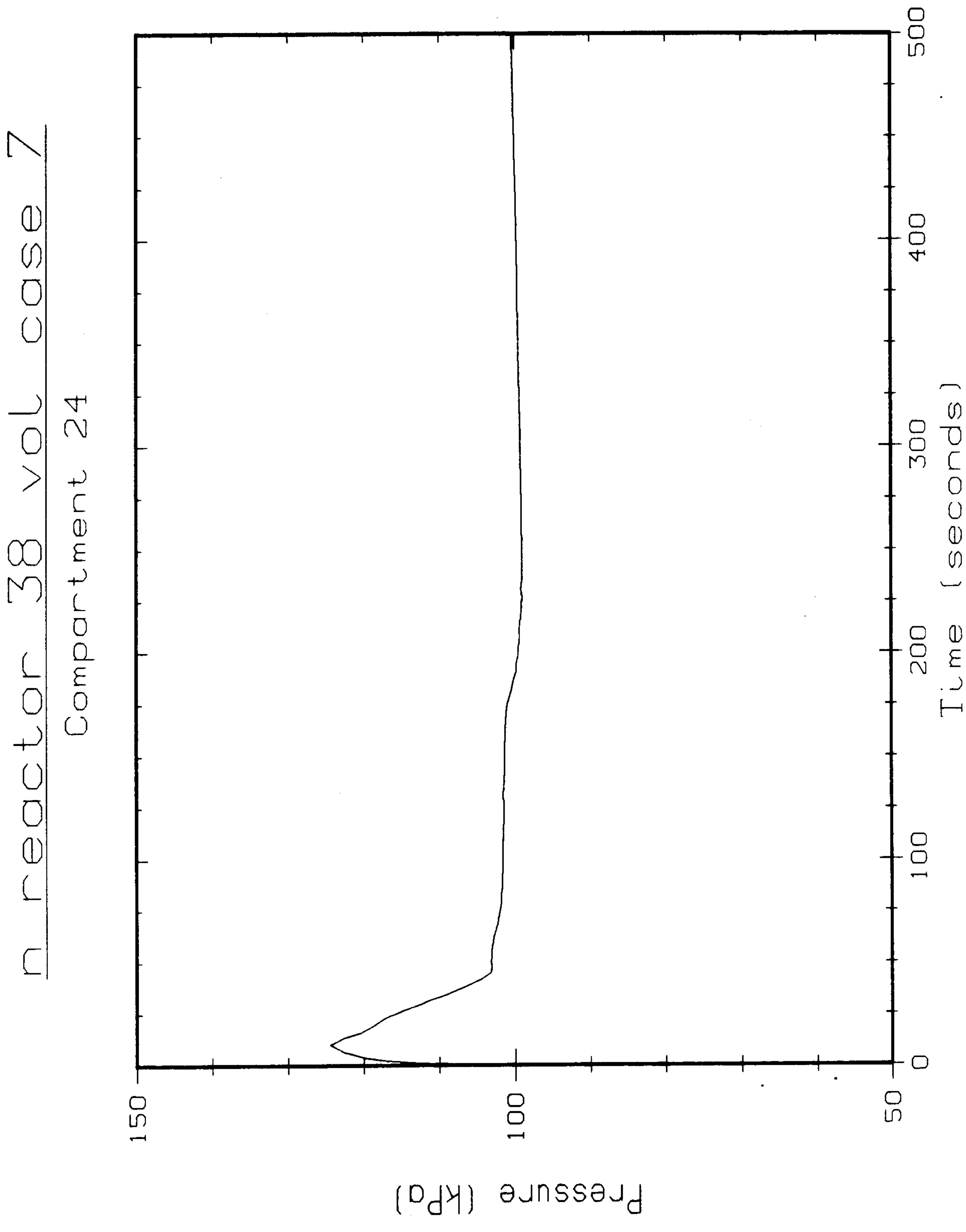

n reactor 38 vol case 7
Compartment 1
tbulk
tsat
Temperature (Kelvin)
Time (seconds)
800
700
600
500
400
300
200
0
100
200
300
400
500

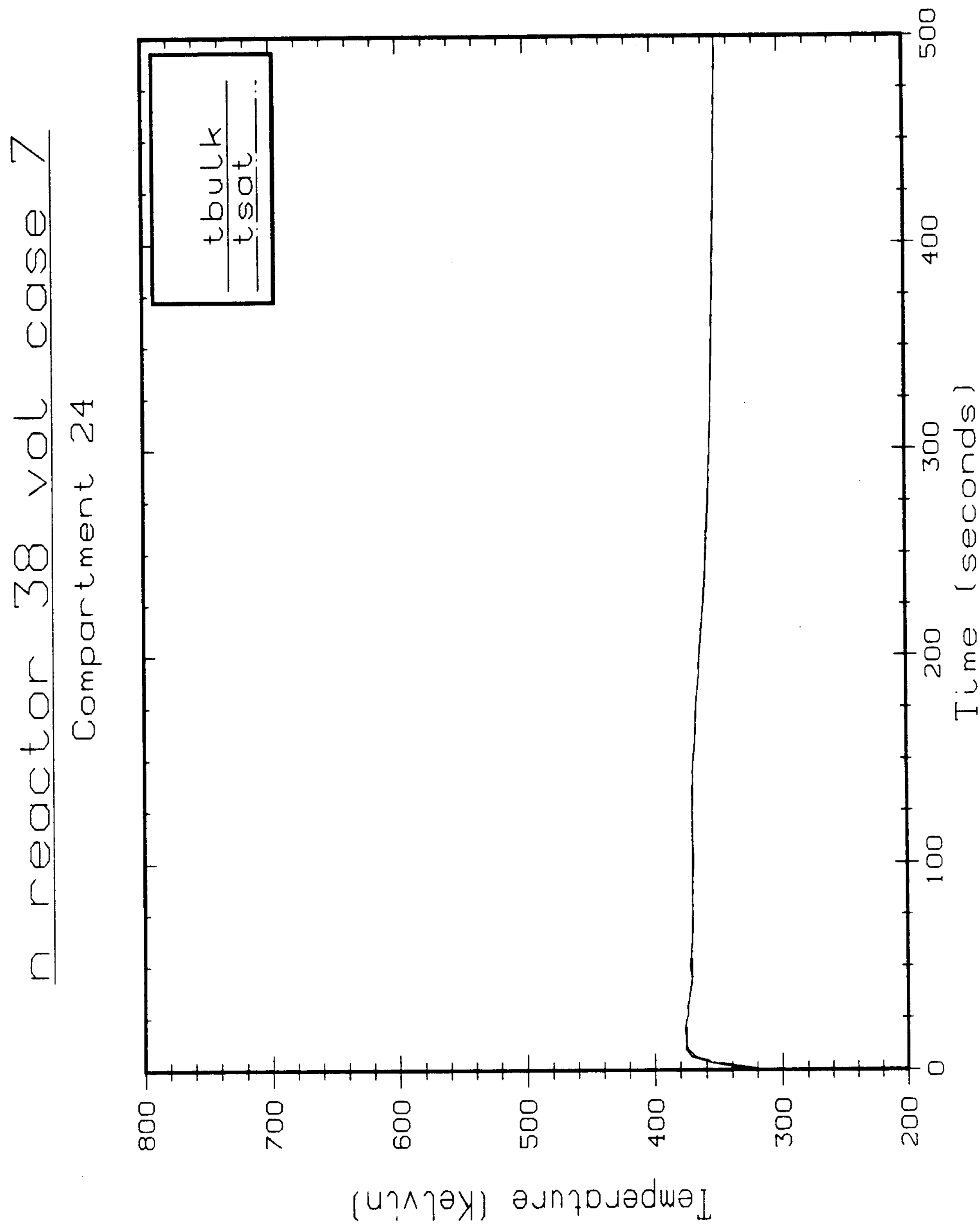

n reactor 38 vol case 7
Compartment 1
Mole Fractions
steam
O2
H2
Gas Mole Fractions
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

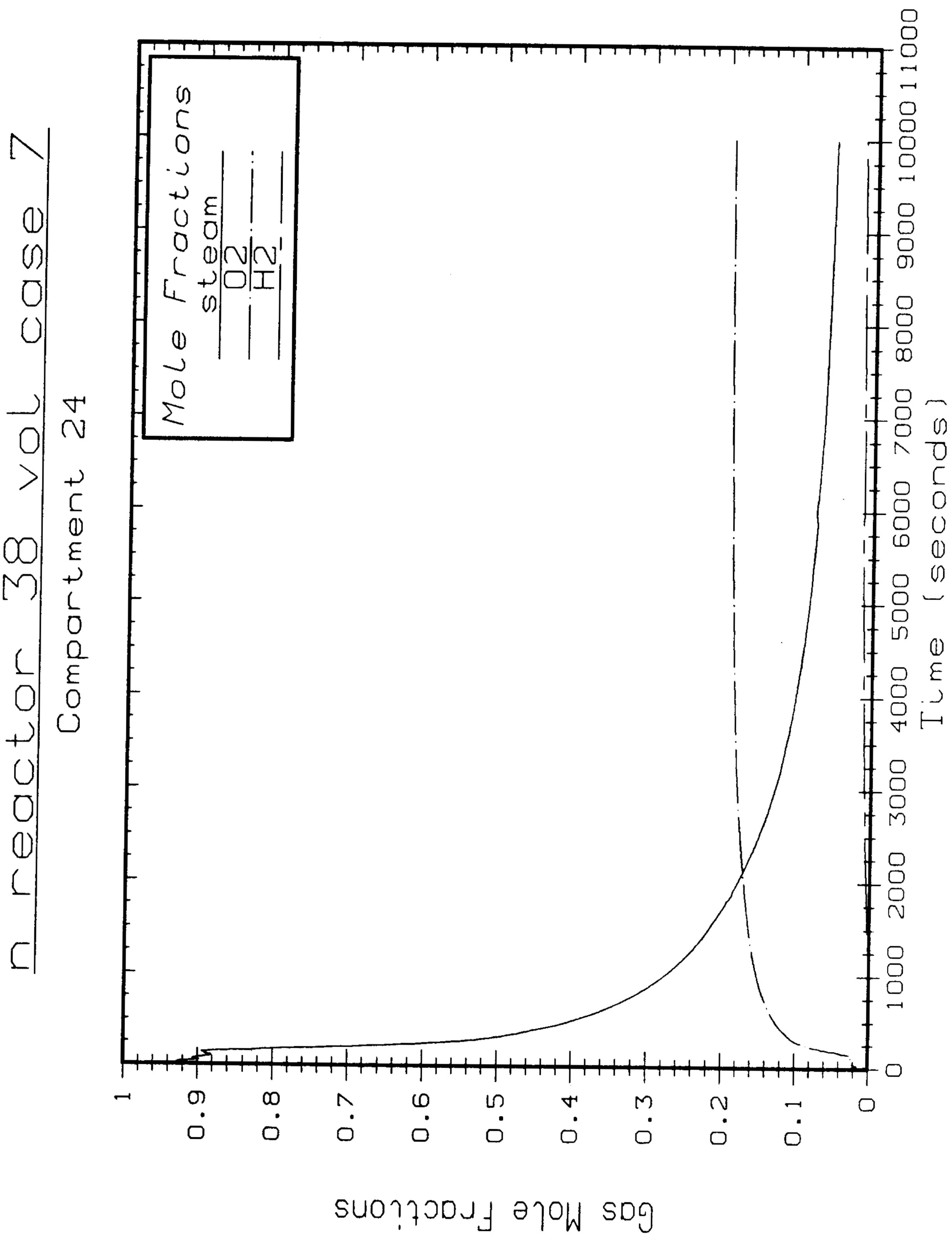

n reactor 38 vol case 7
Compartment 35
Pressure (kPa)
Time (seconds)
150
100
50
0
100
200
300
400
500

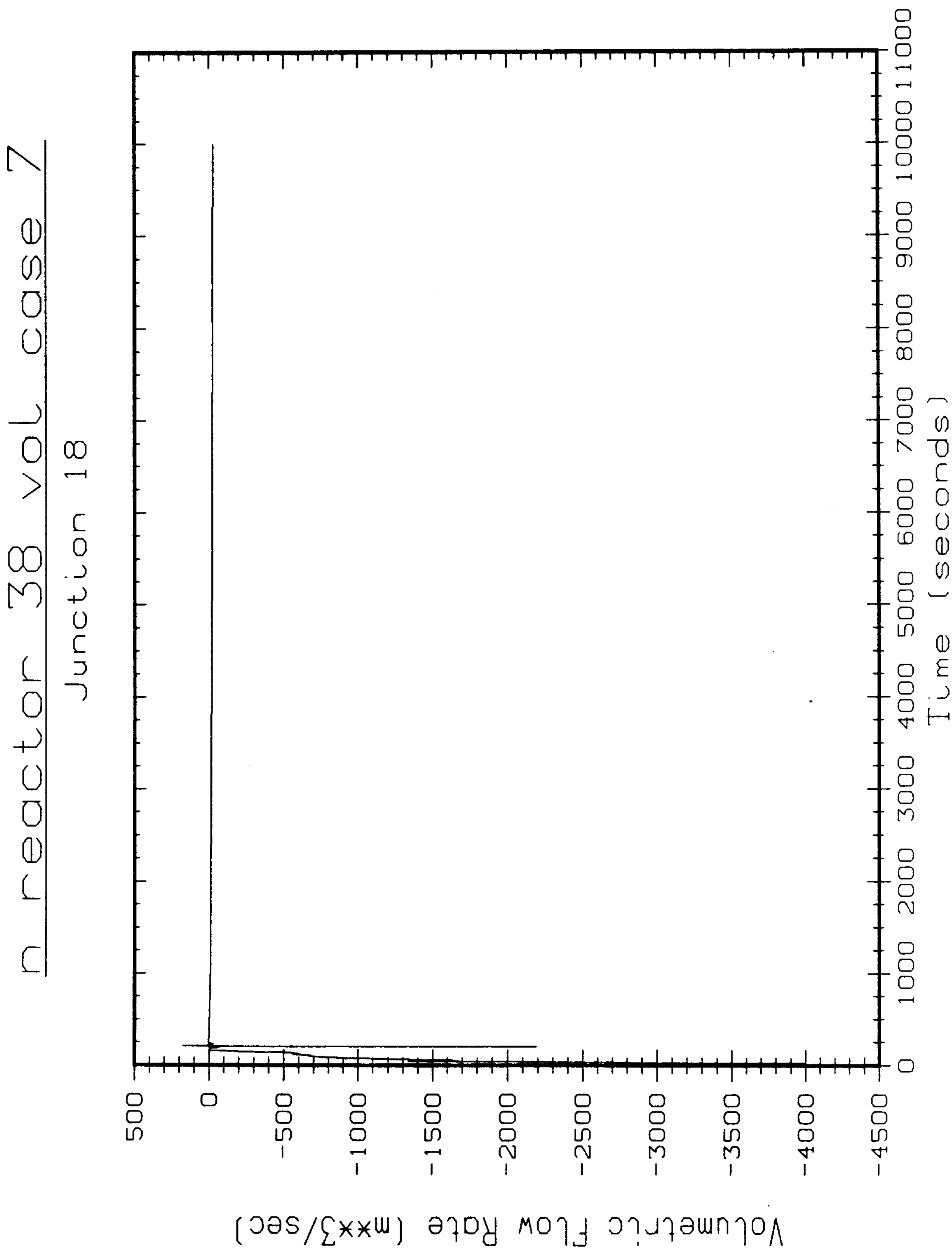

n reactor 38 vol case 7
Compartment 35
tbulk
tsat
Temperature (Kelvin)
800
700
600
500
400
300
200
Time (seconds)
0
100
200
300
400
500

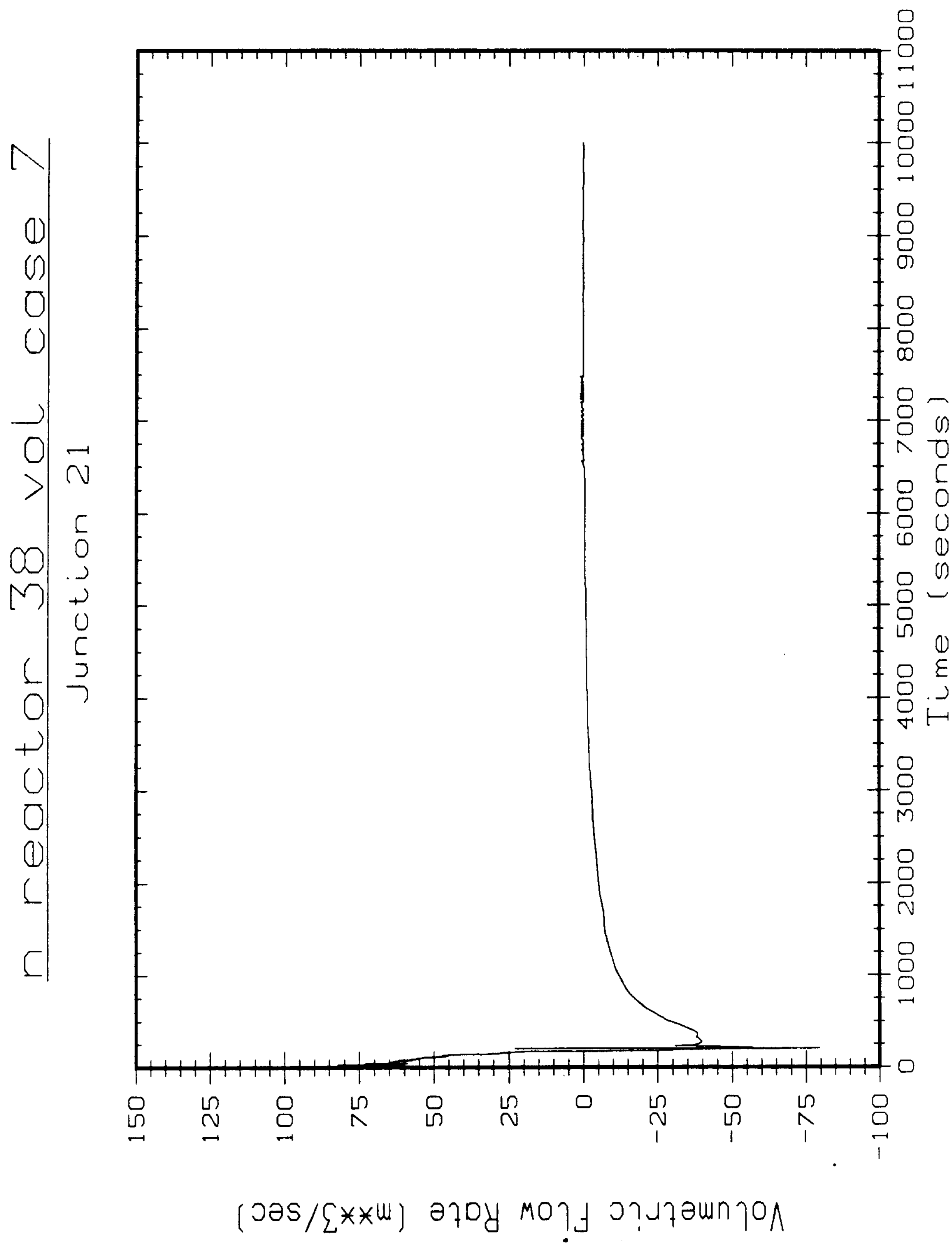

n reactor 38 vol case 7
Compartment 35
Mole Fractions
steam
O2
H2
Gas Mole Fractions
Time (seconds)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

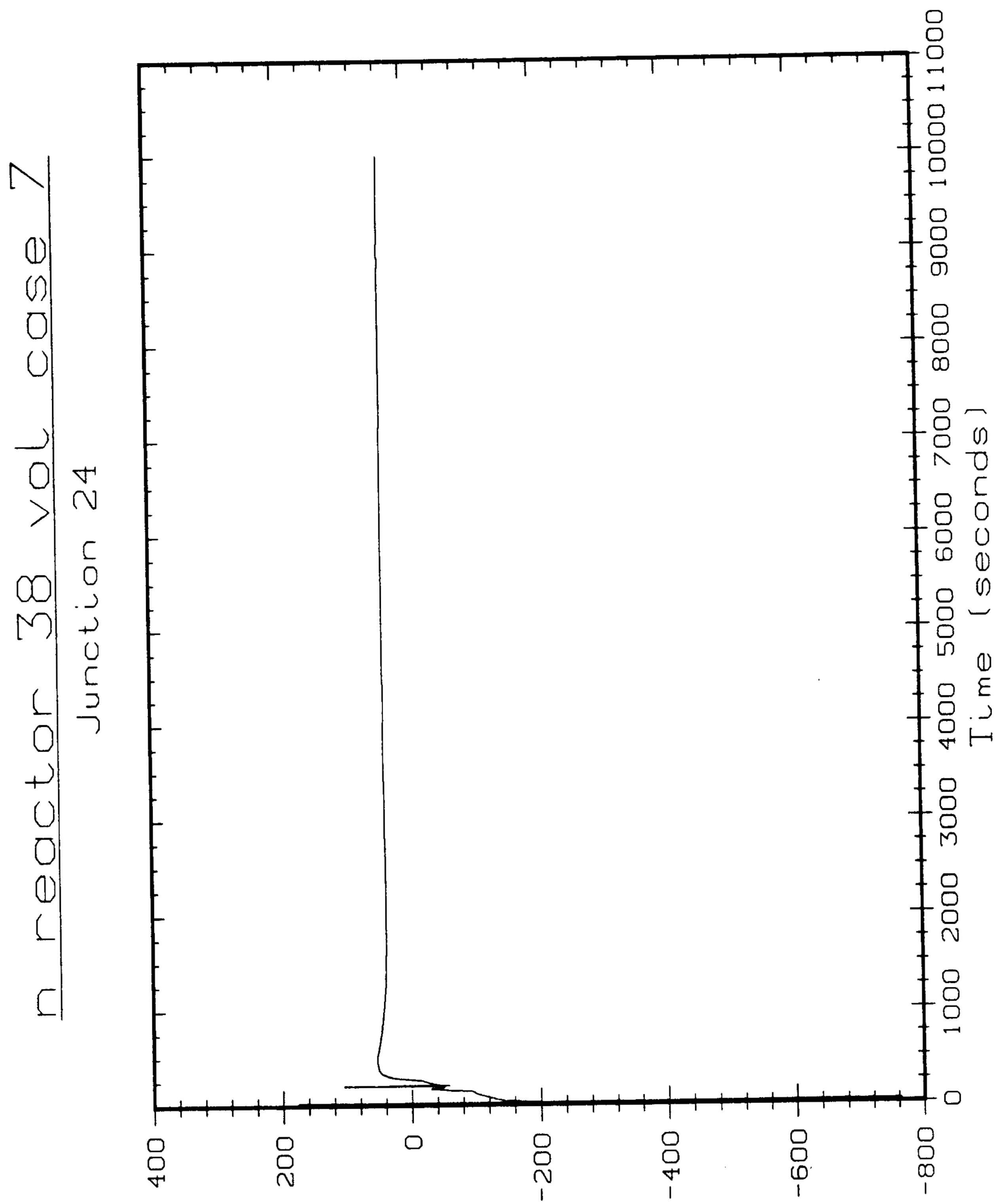

n reactor 38 vol case 7
Compartment 24
Pressure (kPa)
150
100
50
Time (seconds)
0
100
200
300
400
500

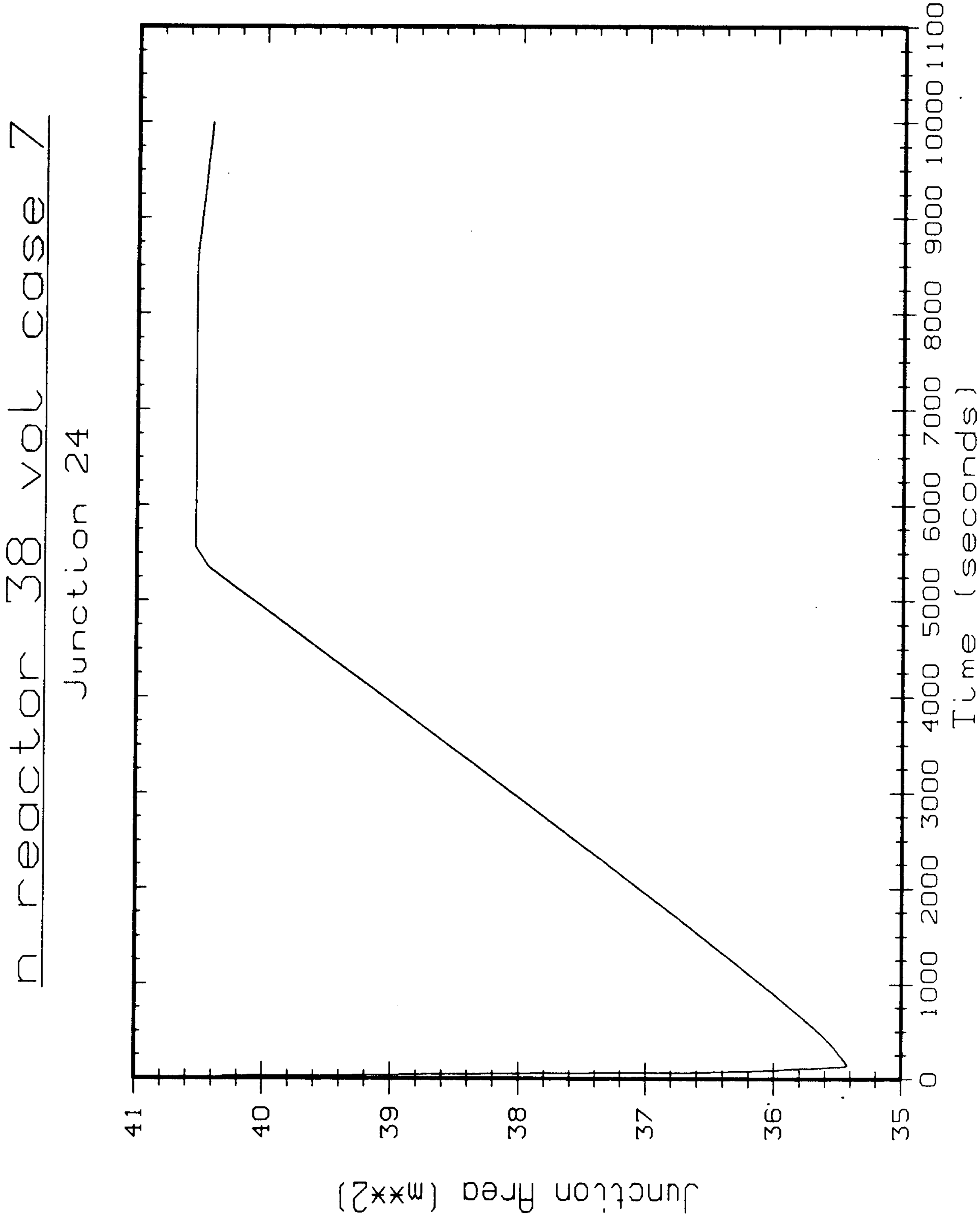

n reactor 38 vol case 7
Compartment 24
tbulk
tsat
Time (seconds)
0
100
200
300
400
500
Temperature (Kelvin)
200
300
400
500
600
700
800

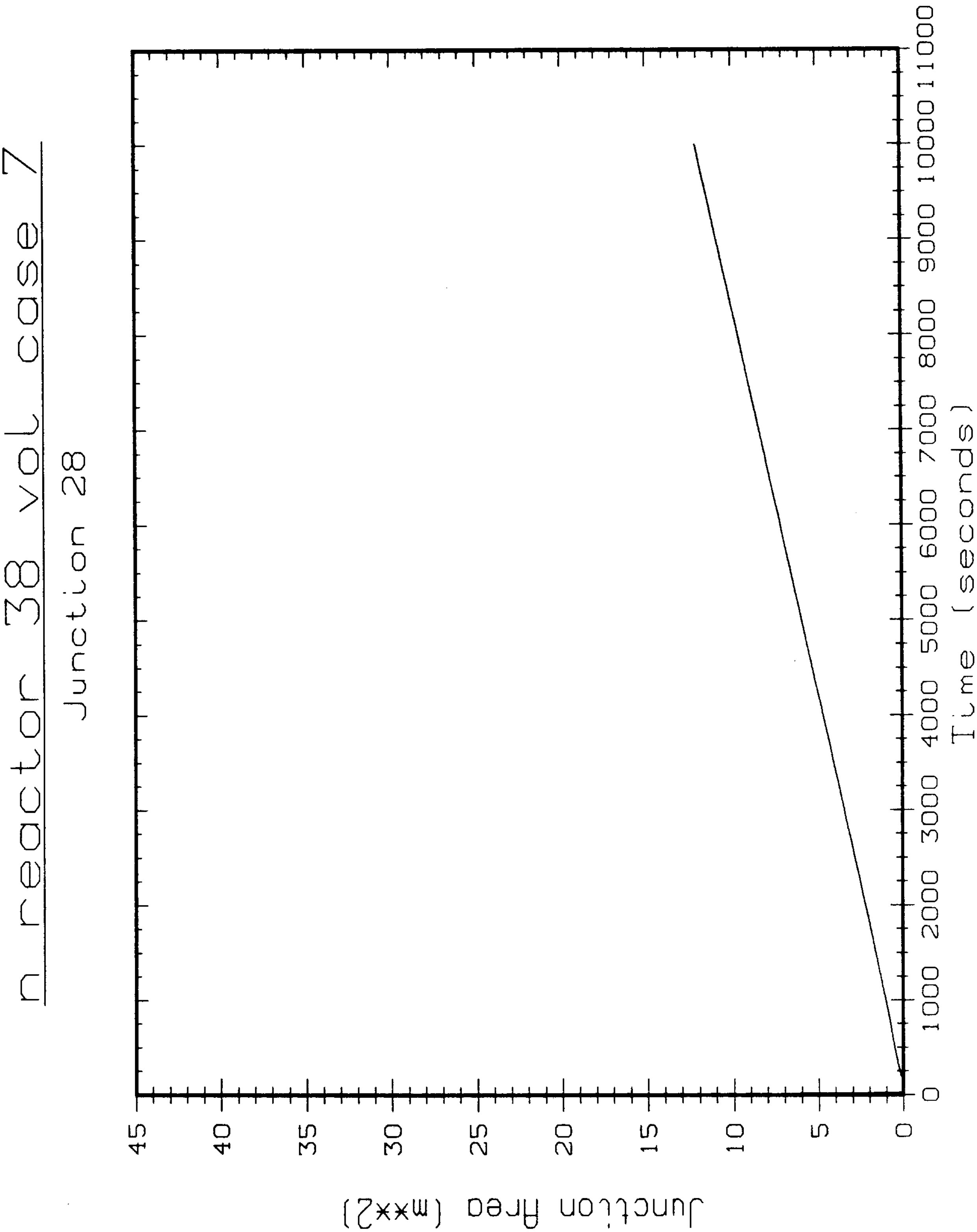

n reactor 38 vol case 7
Compartment 24
Mole Fractions
steam
O2
H2
Gas Mole Fractions
Time (seconds)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000


n reactor 38 vol case 7
Junction 18
Volumetric Flow Rate (m**3/sec)
Time (seconds)
500
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000
-4500
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000


n reactor 38 vol case 7
Junction 21
Volumetric Flow Rate (m**3/sec)
150
125
100
75
50
25
0
-25
-50
-75
-100
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

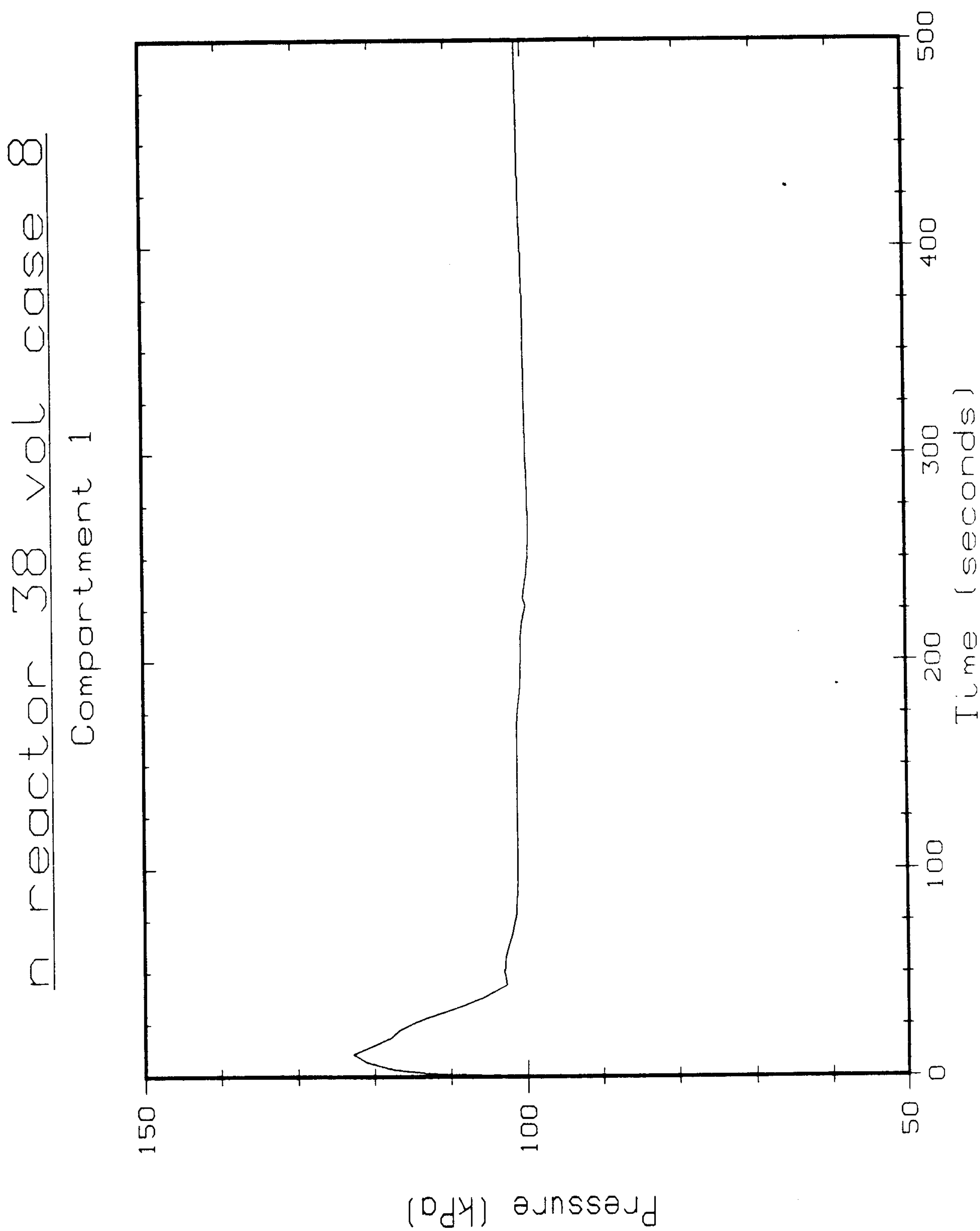

n reactor 38 vol case 7
Junction 24
Volumetric Flow Rate (m**3/sec)
400
200
0
-200
-400
-600
-800
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

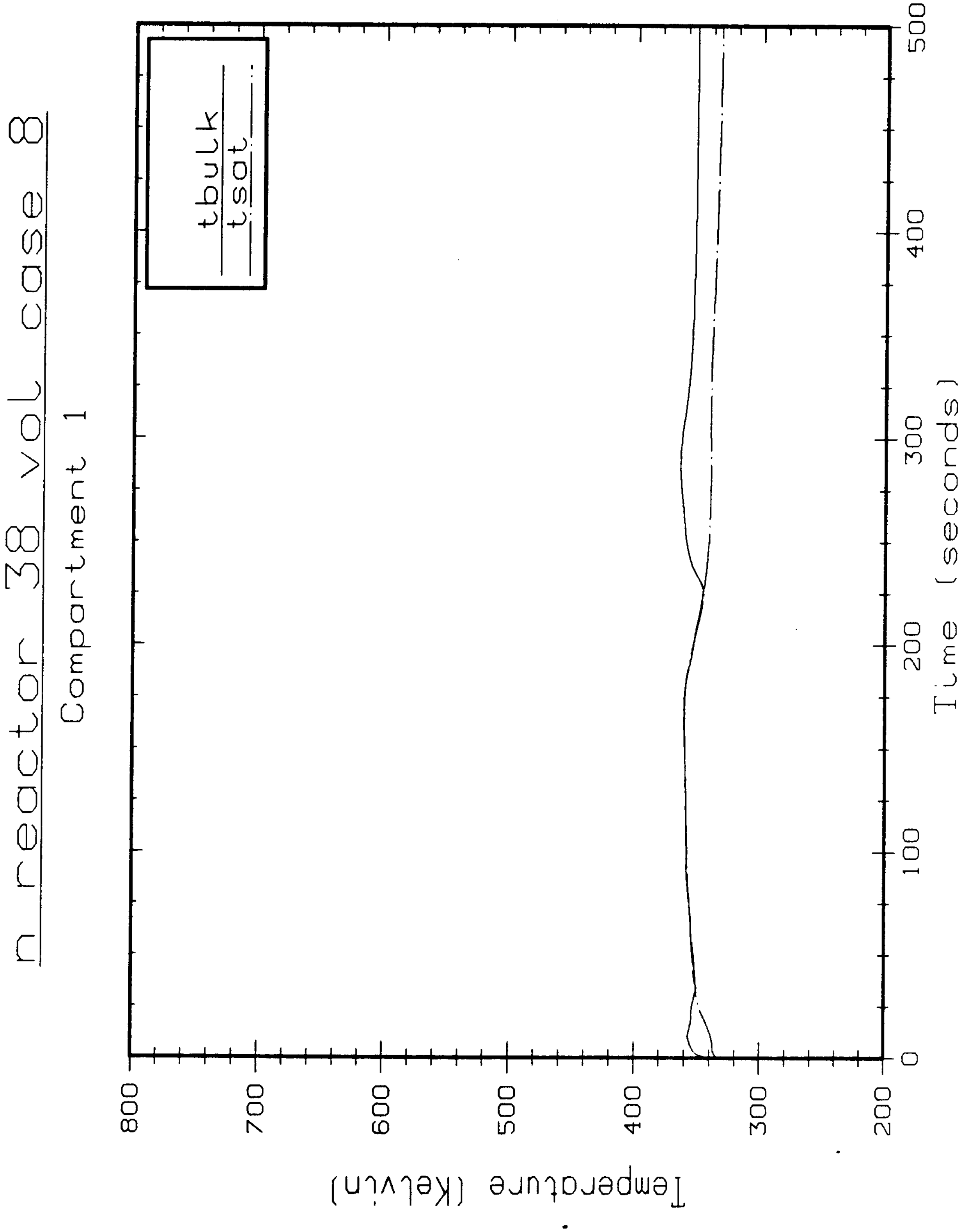

n reactor 38 vol case 7
Junction 24
Time (seconds)
0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000
Junction Area (m**2)
35 36 37 38 39 40 41

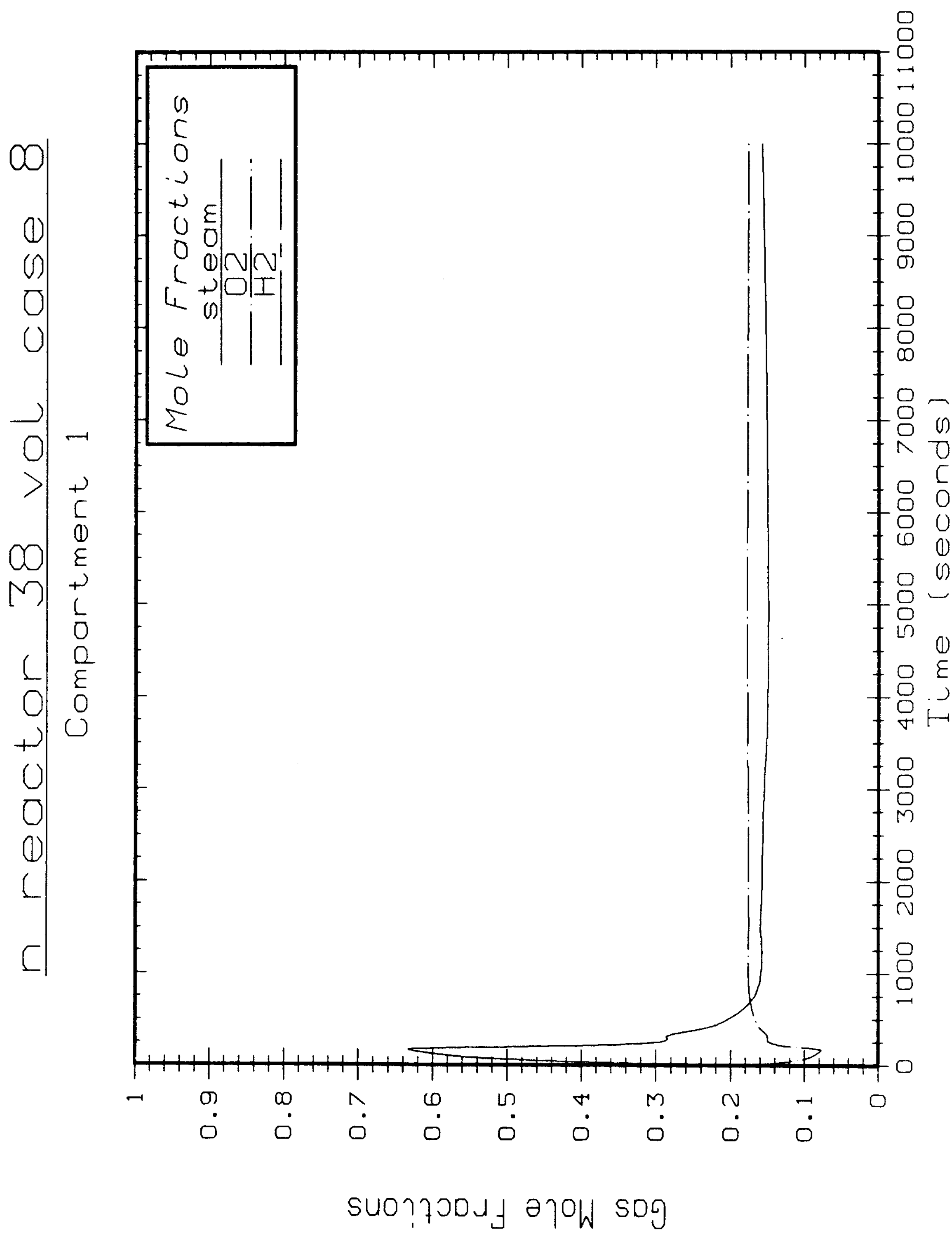

n reactor 38 vol case 7
Junction 28
Junction Area (m**2)
0
5
10
15
20
25
30
35
40
45
Time (seconds)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

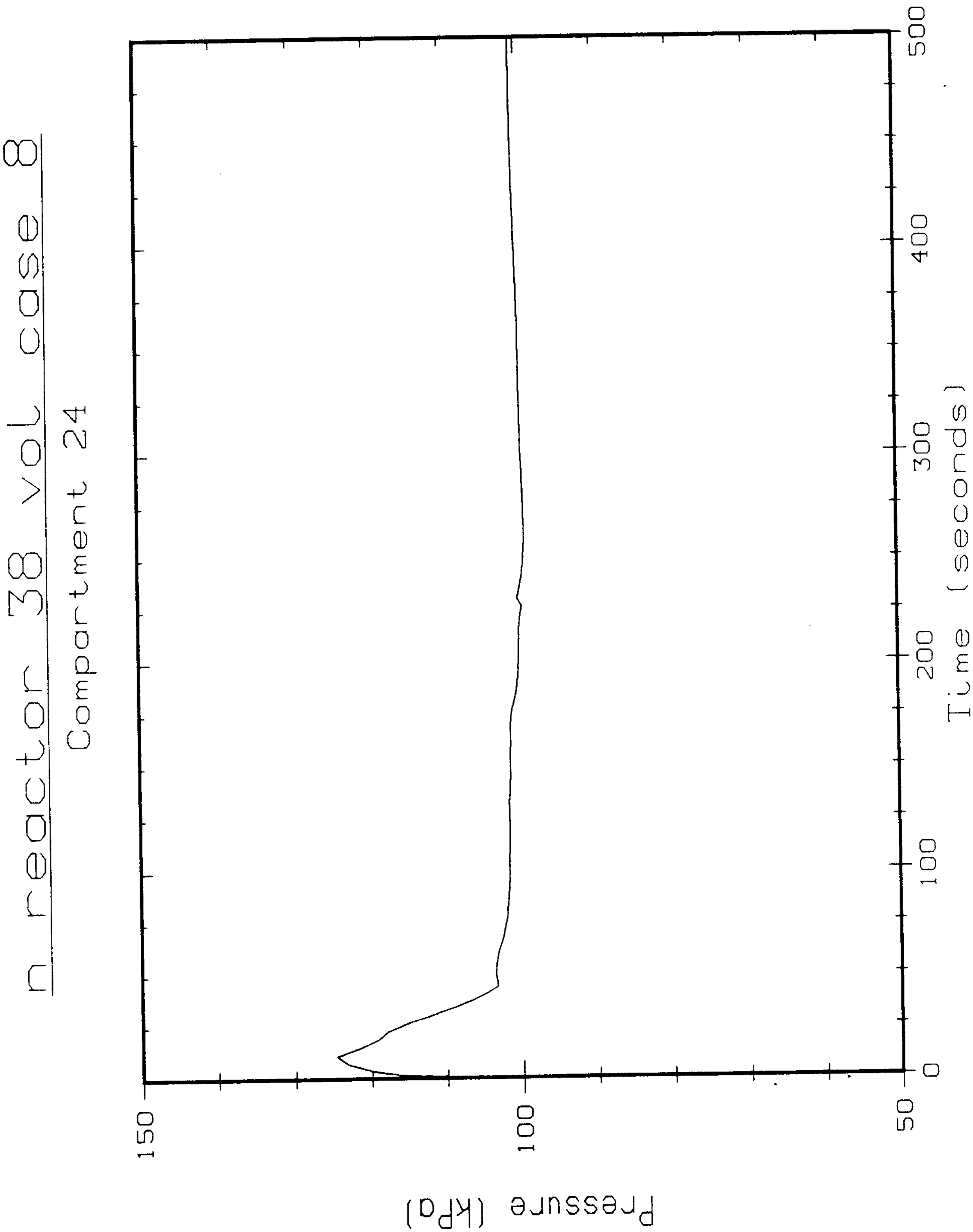
SELECTED PLOTS

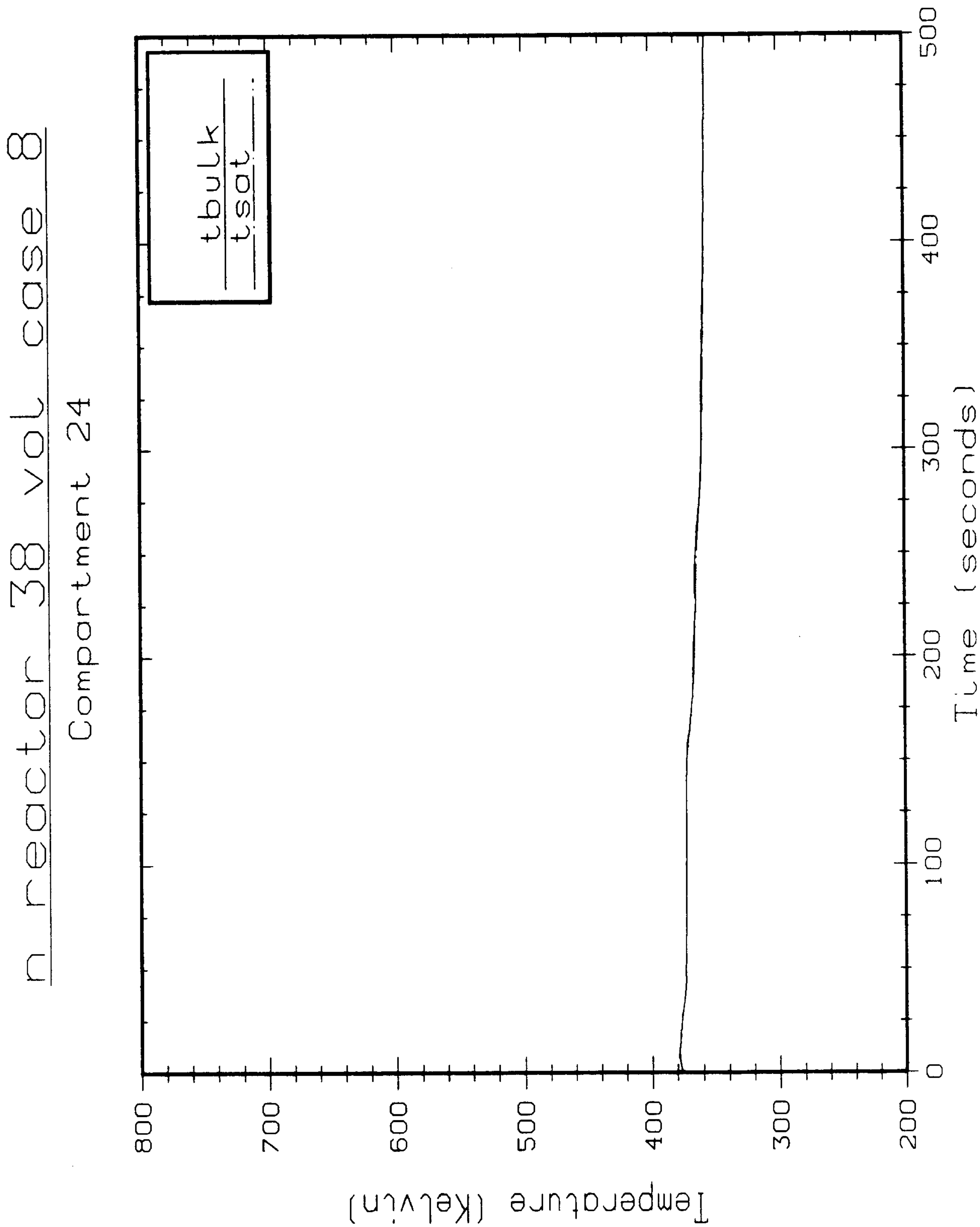
CASE 8

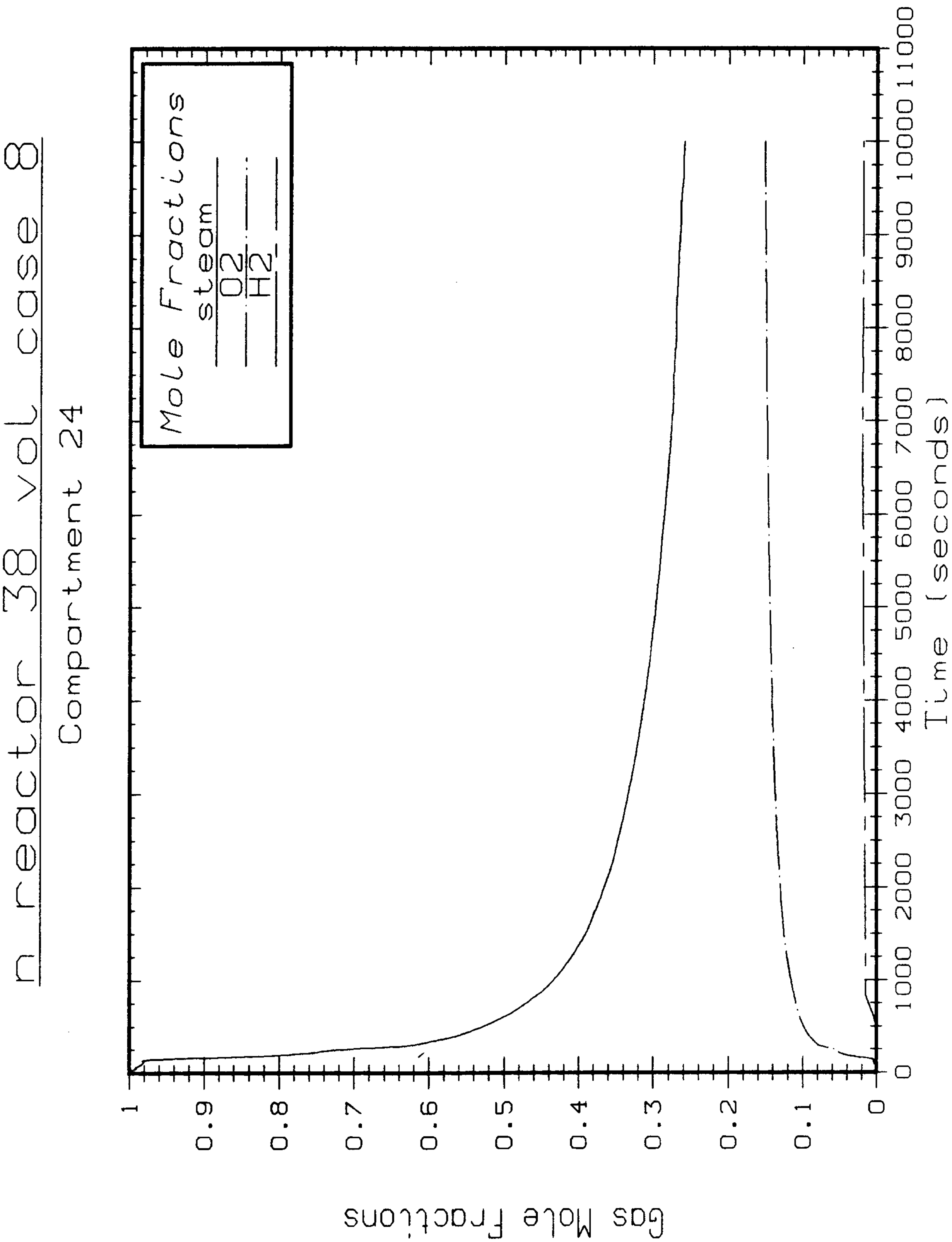

n reactor 38 vol case 8
Compartment 1
Pressure (kPa)
150
100
50
Time (seconds)
0
100
200
300
400
500


n reactor 38 vol case 8
Compartment 1
tbulk
tsat
Temperature (Kelvin)
800
700
600
500
400
300
200
Time (seconds)
0
100
200
300
400
500


n reactor 38 vol case 8
Compartment 1
Mole Fractions
steam
O2
H2
Time (seconds)
Gas Mole Fractions
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

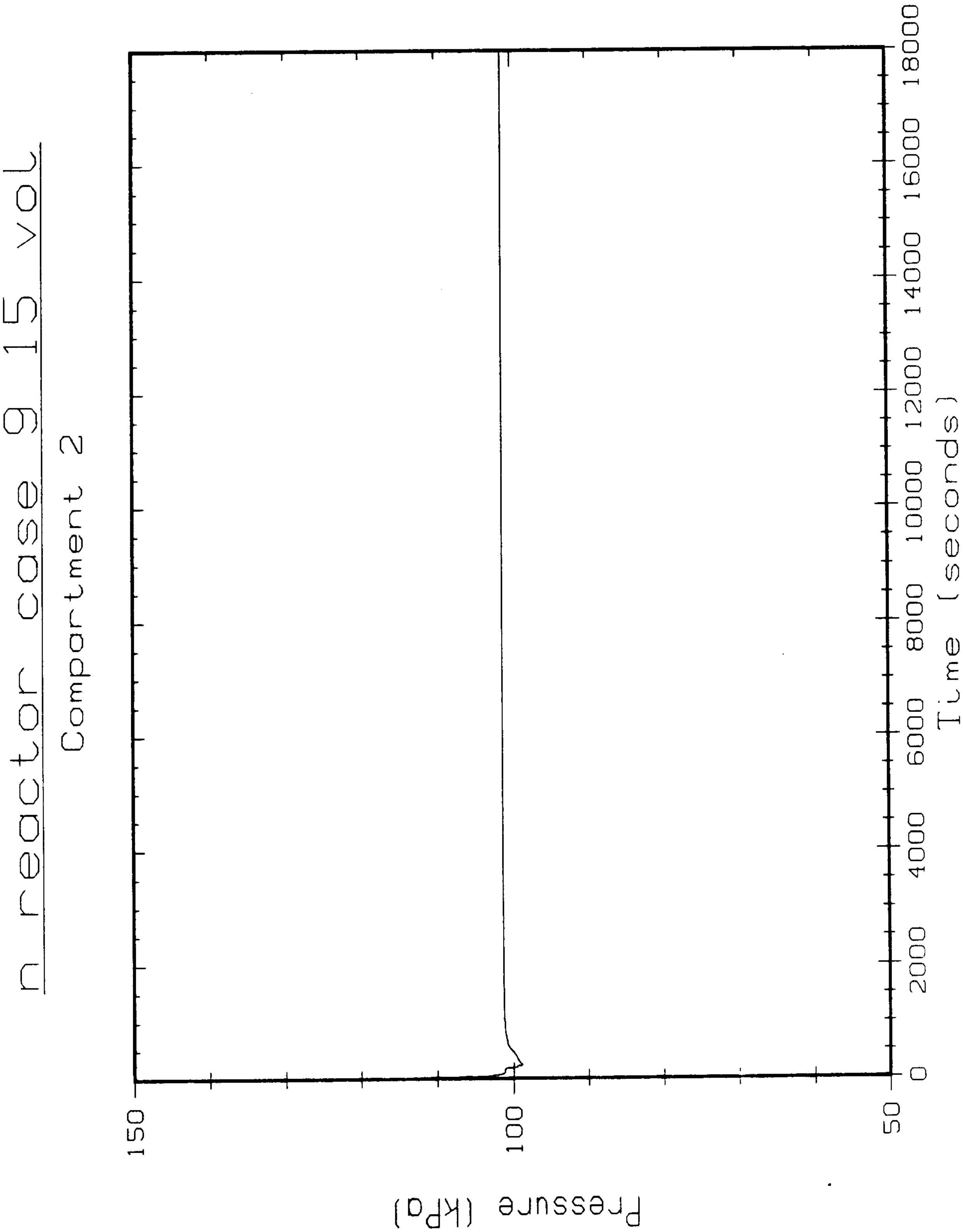

n reactor 38 vol case 8
Compartment 24
Pressure (kPa)
Time (seconds)
150
100
50
0
100
200
300
400
500

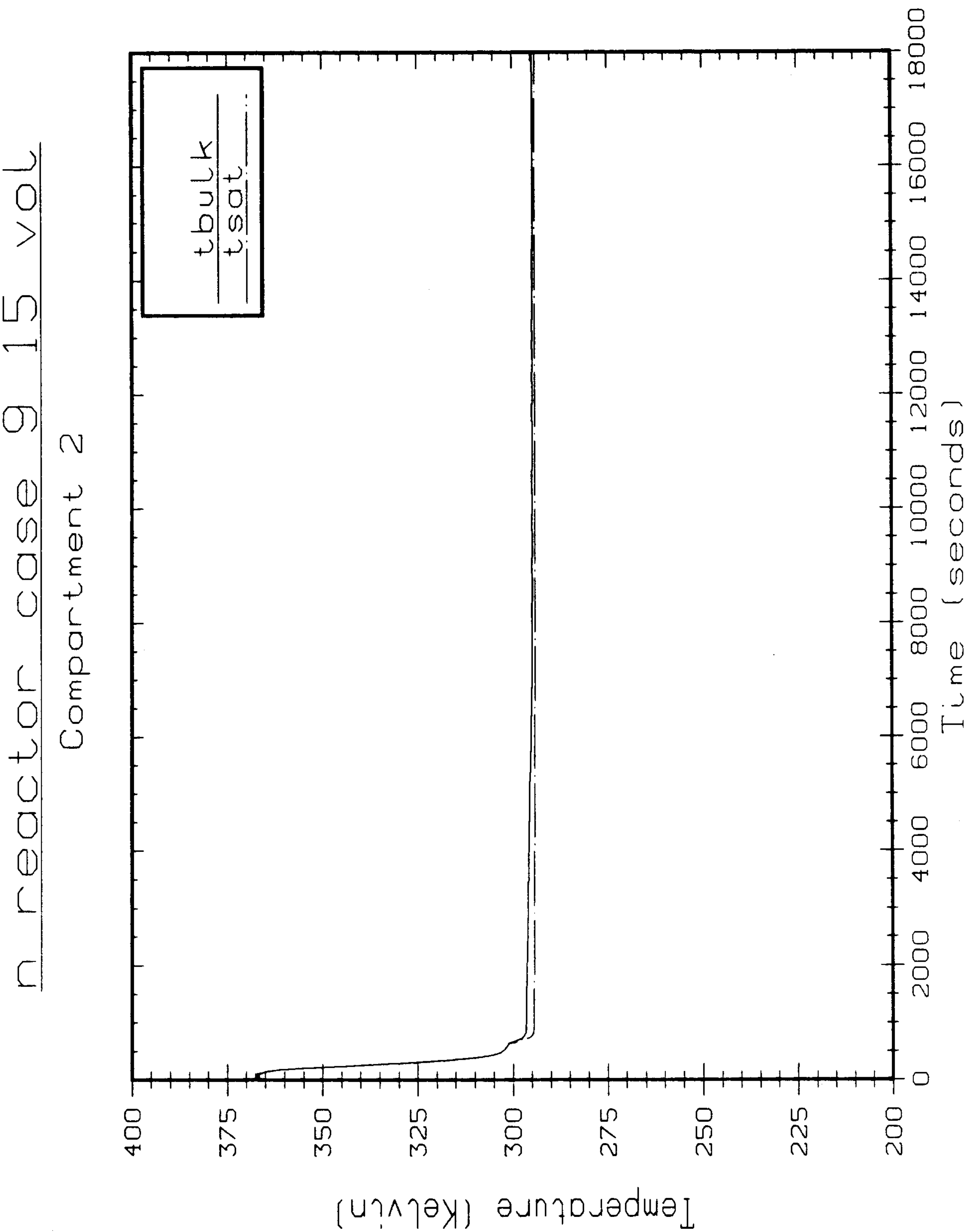

n reactor 38 vol case 8
Compartment 24
tbulk
tsat
Time (seconds)
Temperature (Kelvin)
0
100
200
300
400
500
200
300
400
500
600
700
800

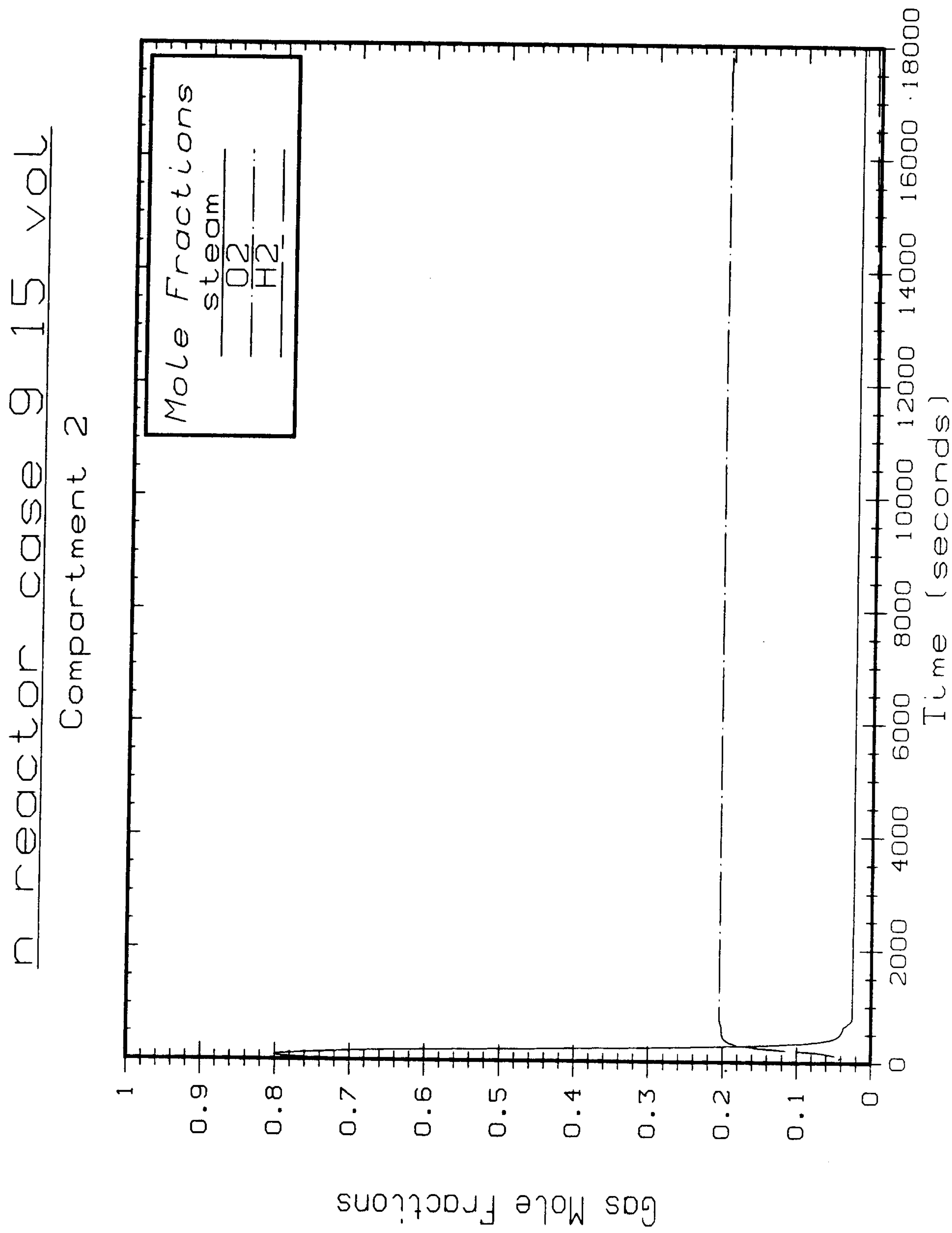

n reactor 38 vol case 8
Compartment 24
Mole Fractions
steam
O2
H2
Time (seconds)
Gas Mole Fractions
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

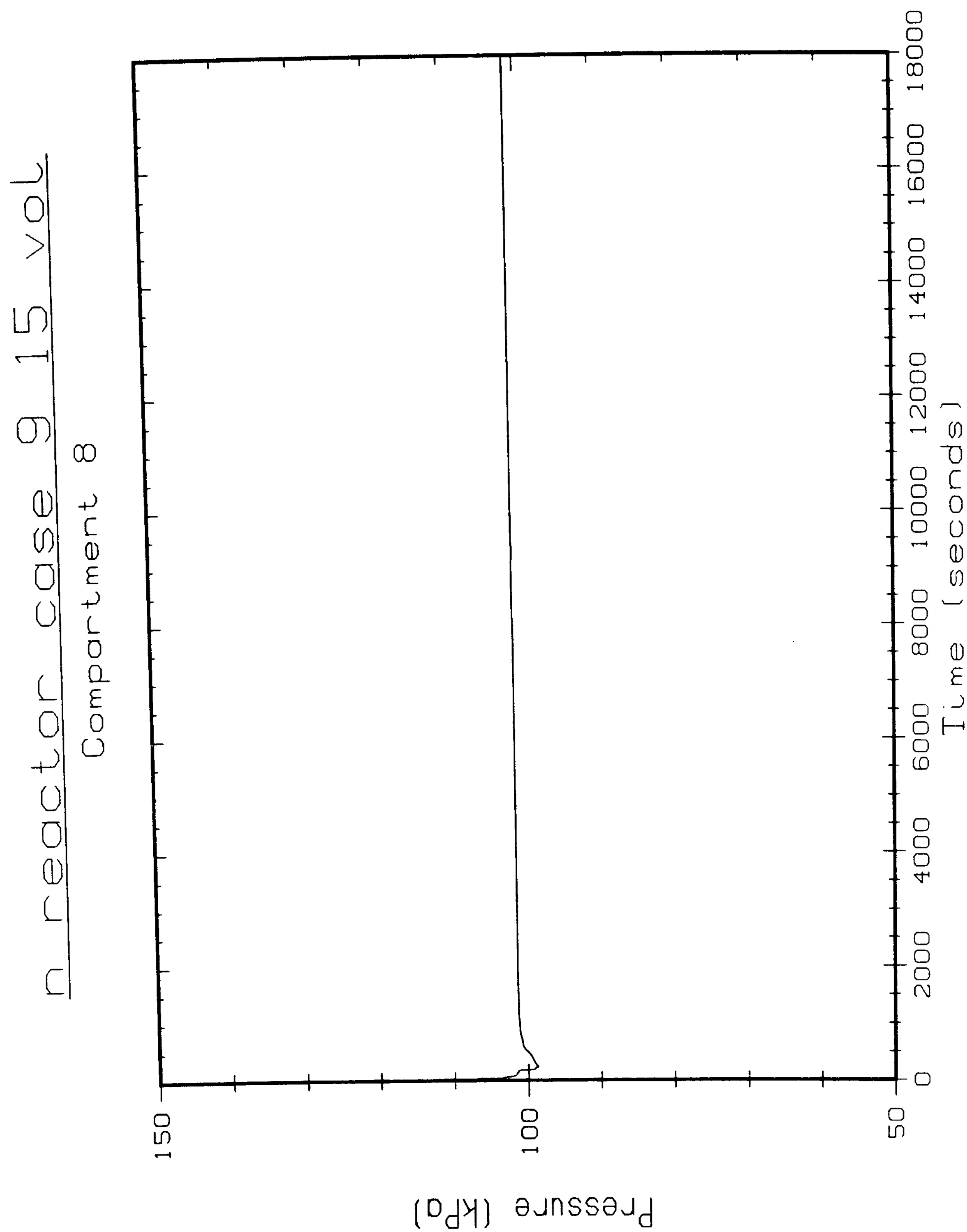
SELECTED PLOTS

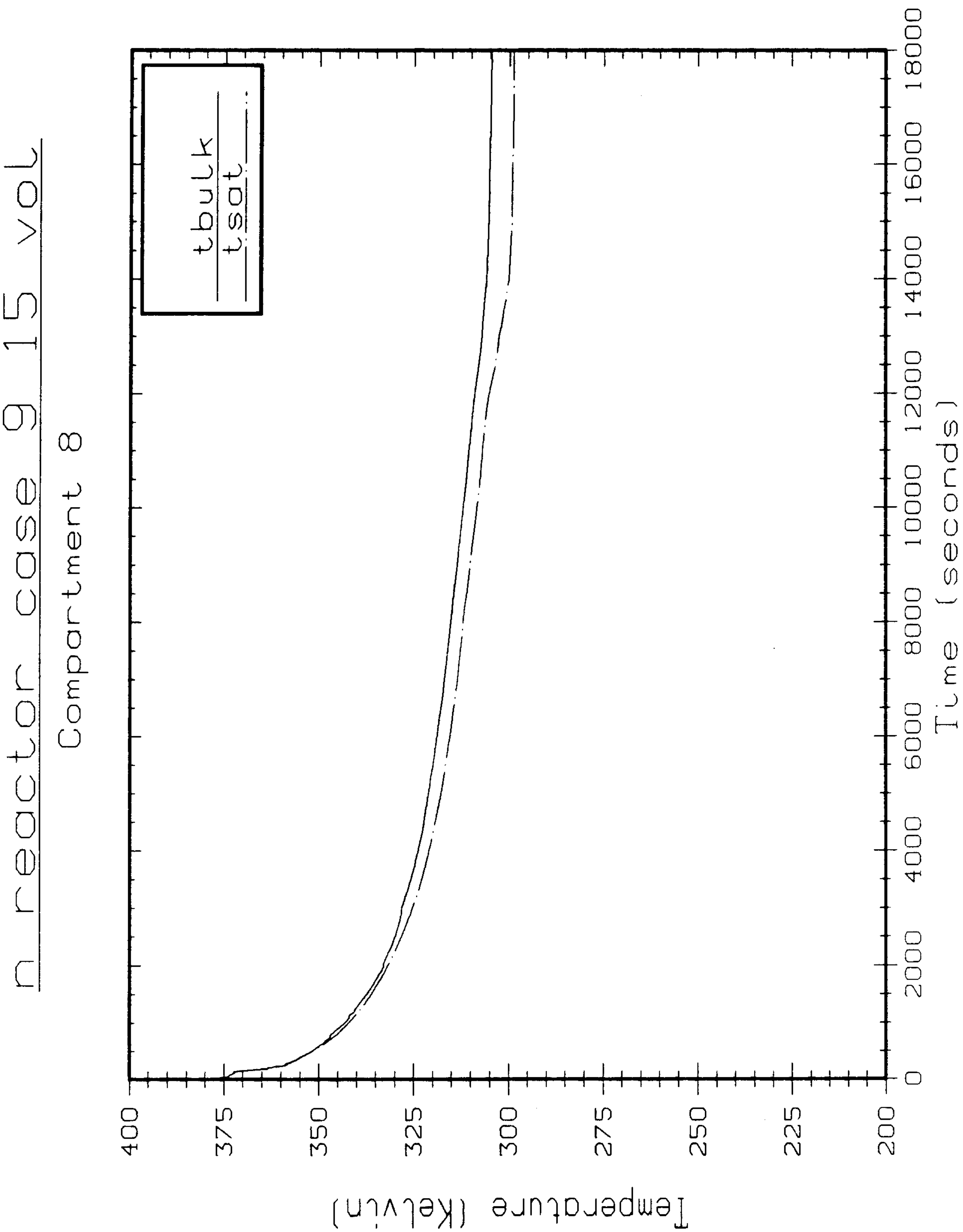
CASE 9

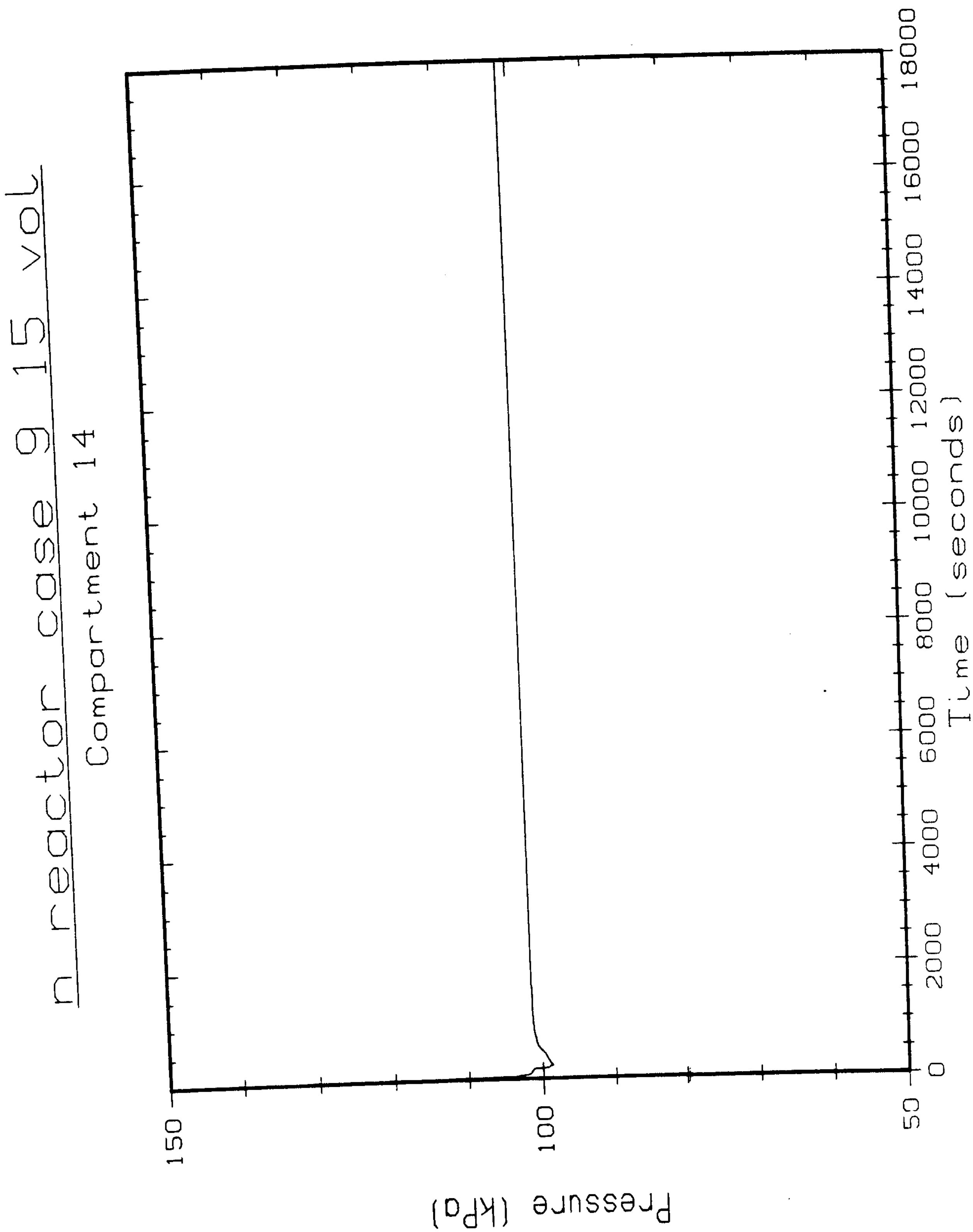

n reactor case 9 15 vol
Compartment 2
Pressure (kPa)
150
100
50
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

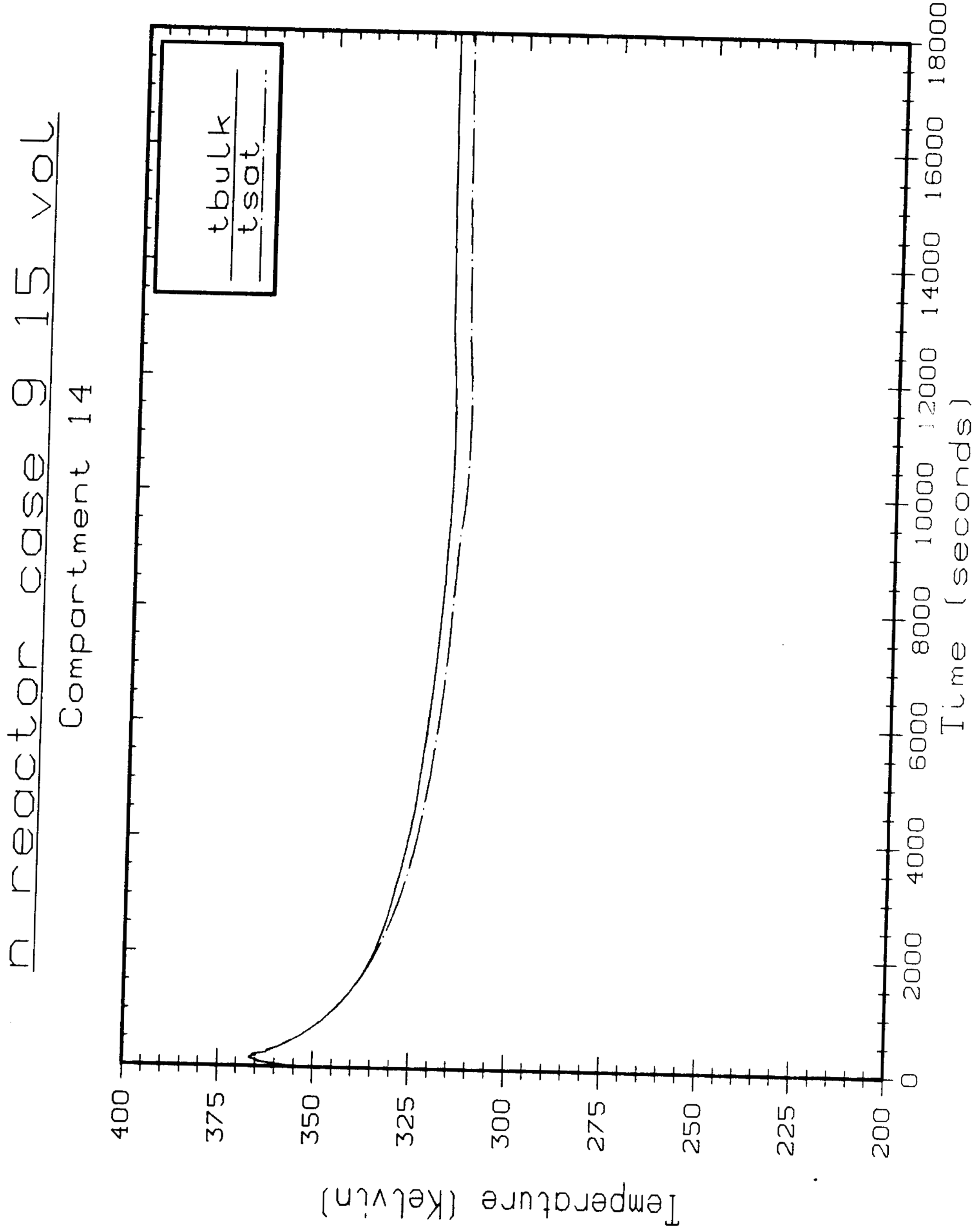

n reactor case 9 15 vol
Compartment 2
tbulk
tsat
Temperature (Kelvin)
400
375
350
325
300
275
250
225
200
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

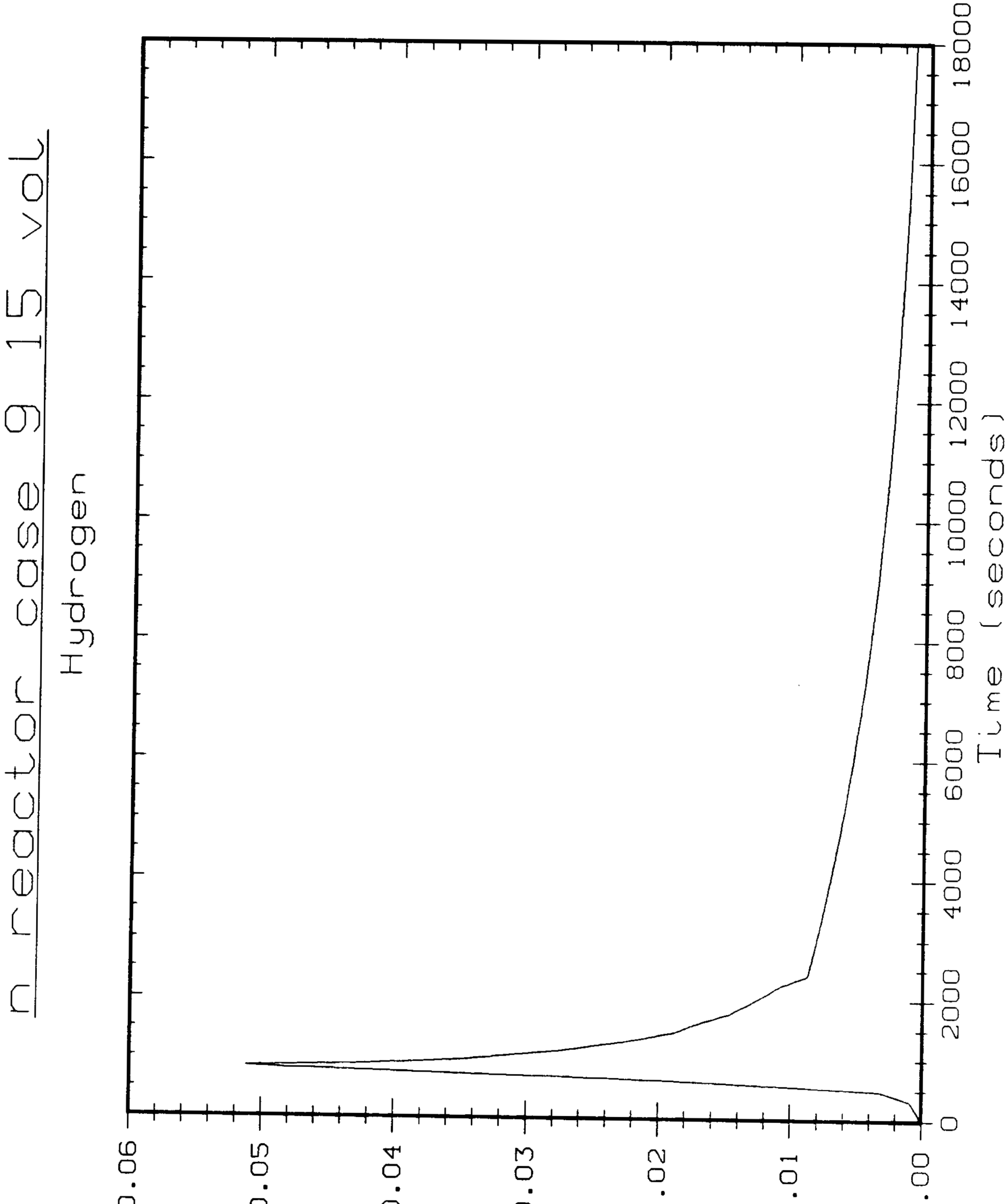

n reactor case 9 15 vol
Compartment 2
Mole Fractions
steam
O2
H2
Gas Mole Fractions
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

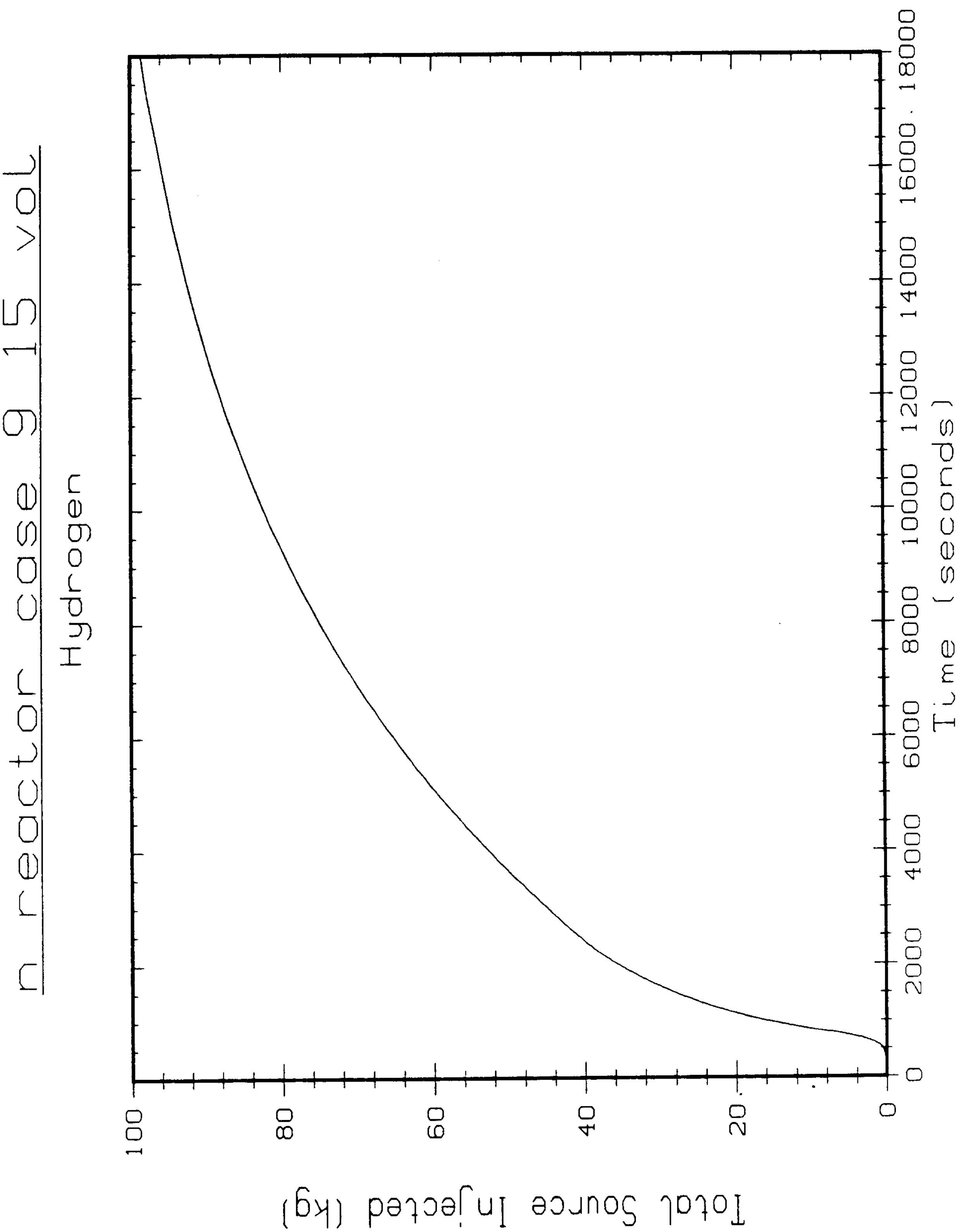

n reactor case 9 15 vol
Compartment 8
Pressure (kPa)
150
100
50
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

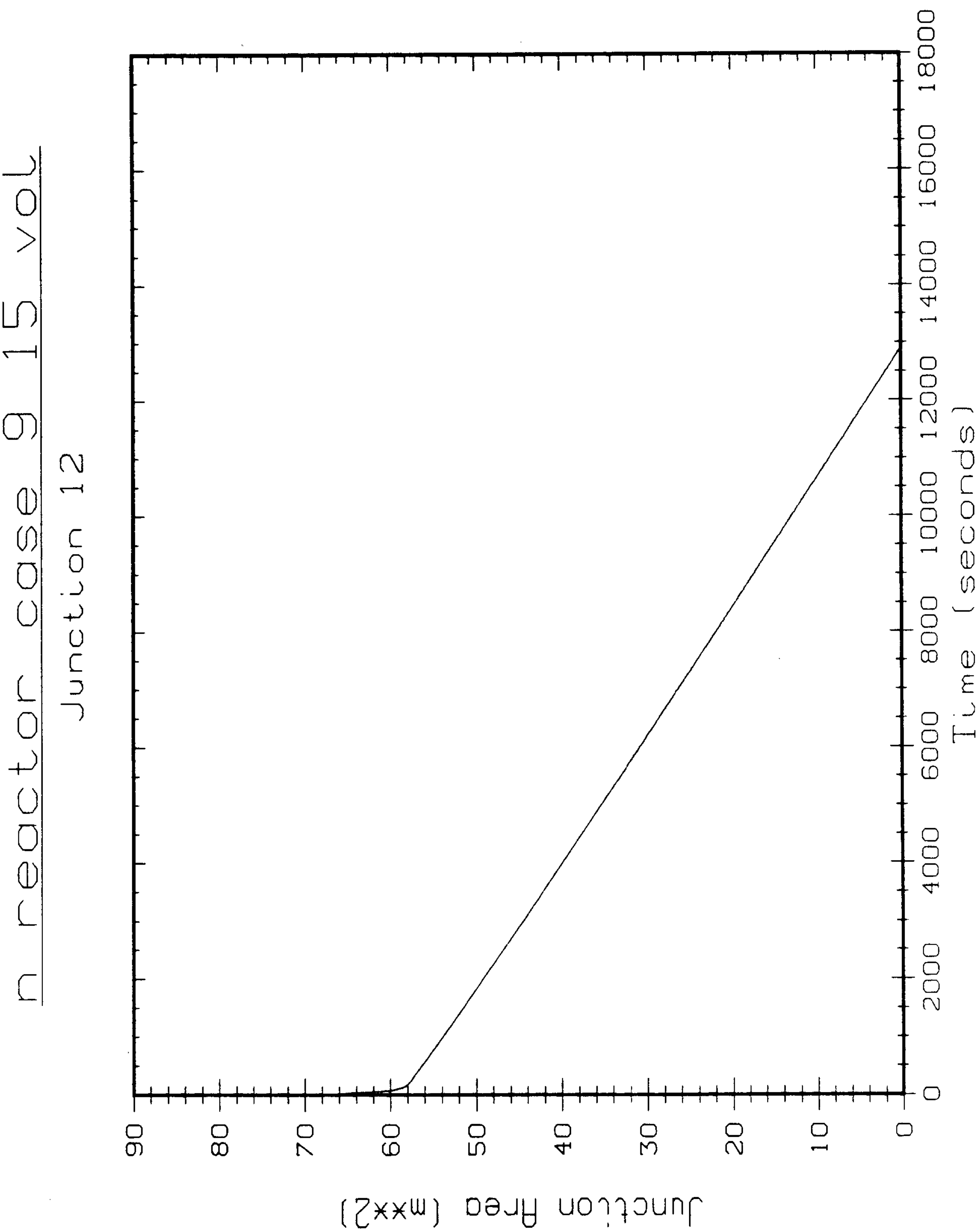

n reactor case 9 15 vol
Compartment 8
tbulk
tsat
Temperature (Kelvin)
400
375
350
325
300
275
250
225
200
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

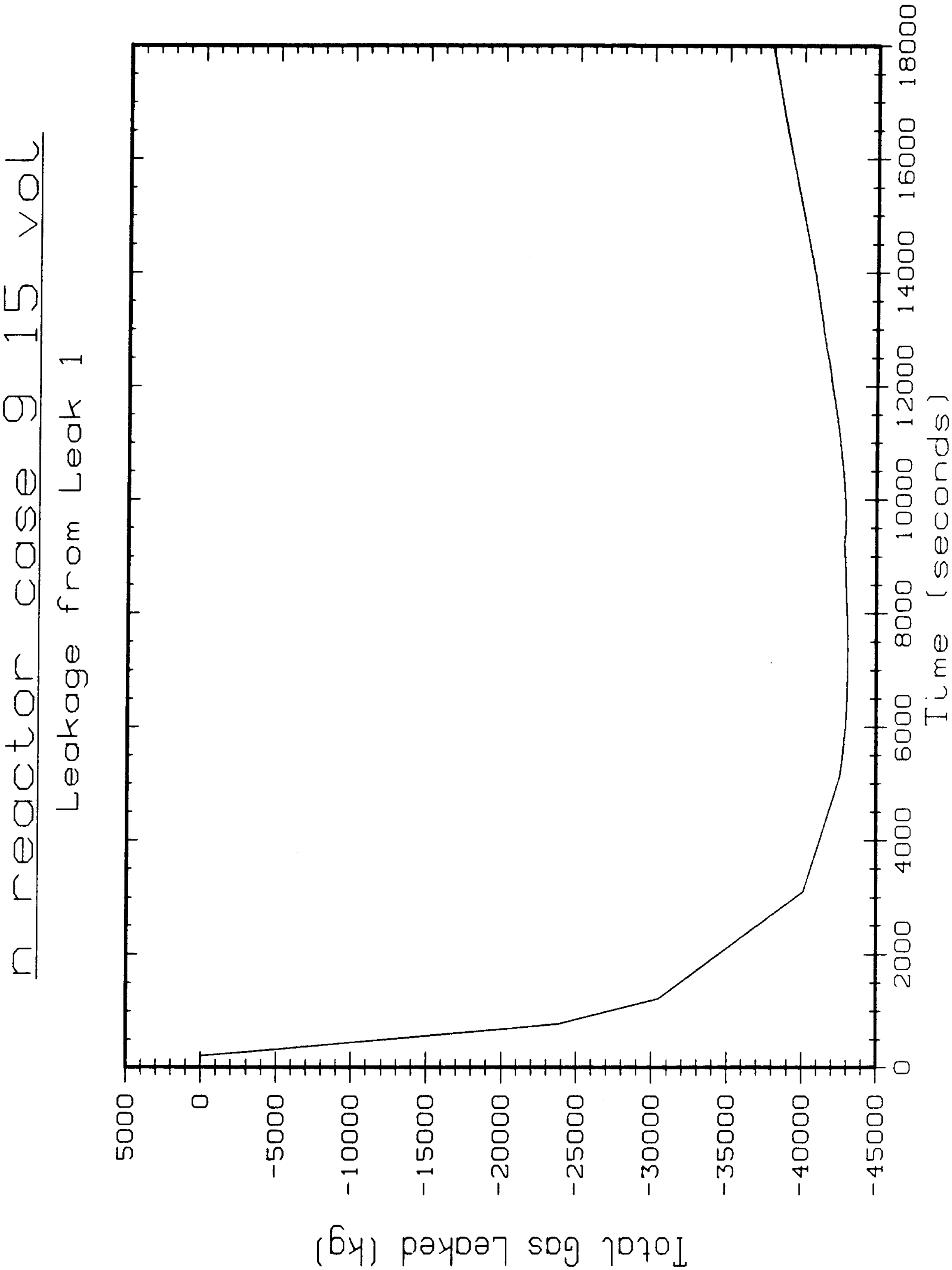

n reactor case 9 15 vol
Compartment 14
Pressure (kPa)
150
100
50
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000


n reactor case 9 15 vol
Compartment 14
tbulk
tsat
Temperature (Kelvin)
400
375
350
325
300
275
250
225
200
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000


n reactor case 9 15 vol
Hydrogen
Source Injection Rate (kg/sec)
0.00
0.01
0.02
0.03
0.04
0.05
0.06
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

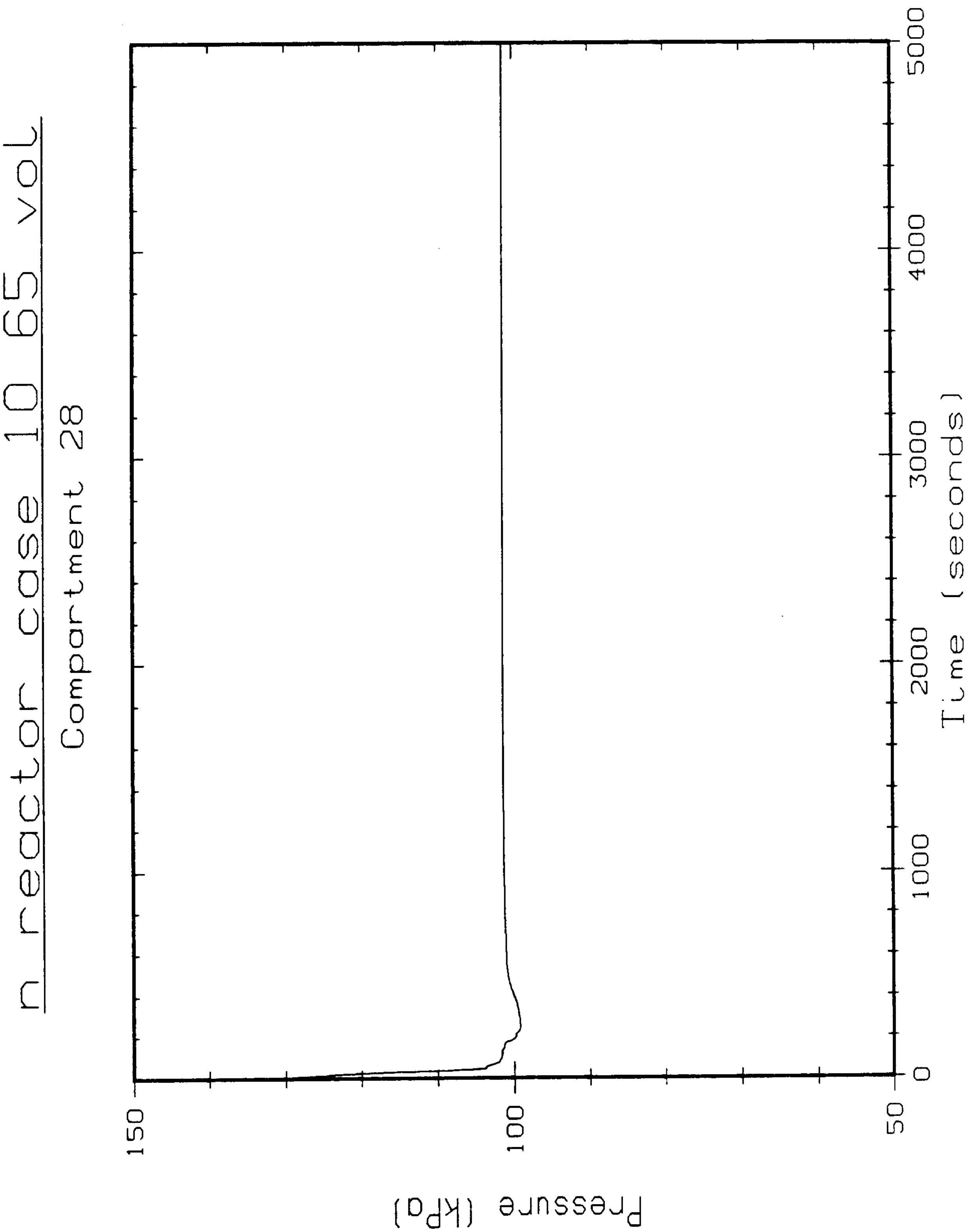

n reactor case 9 15 vol
Hydrogen
Total Source Injected (kg)
0
20
40
60
80
100
Time (seconds)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

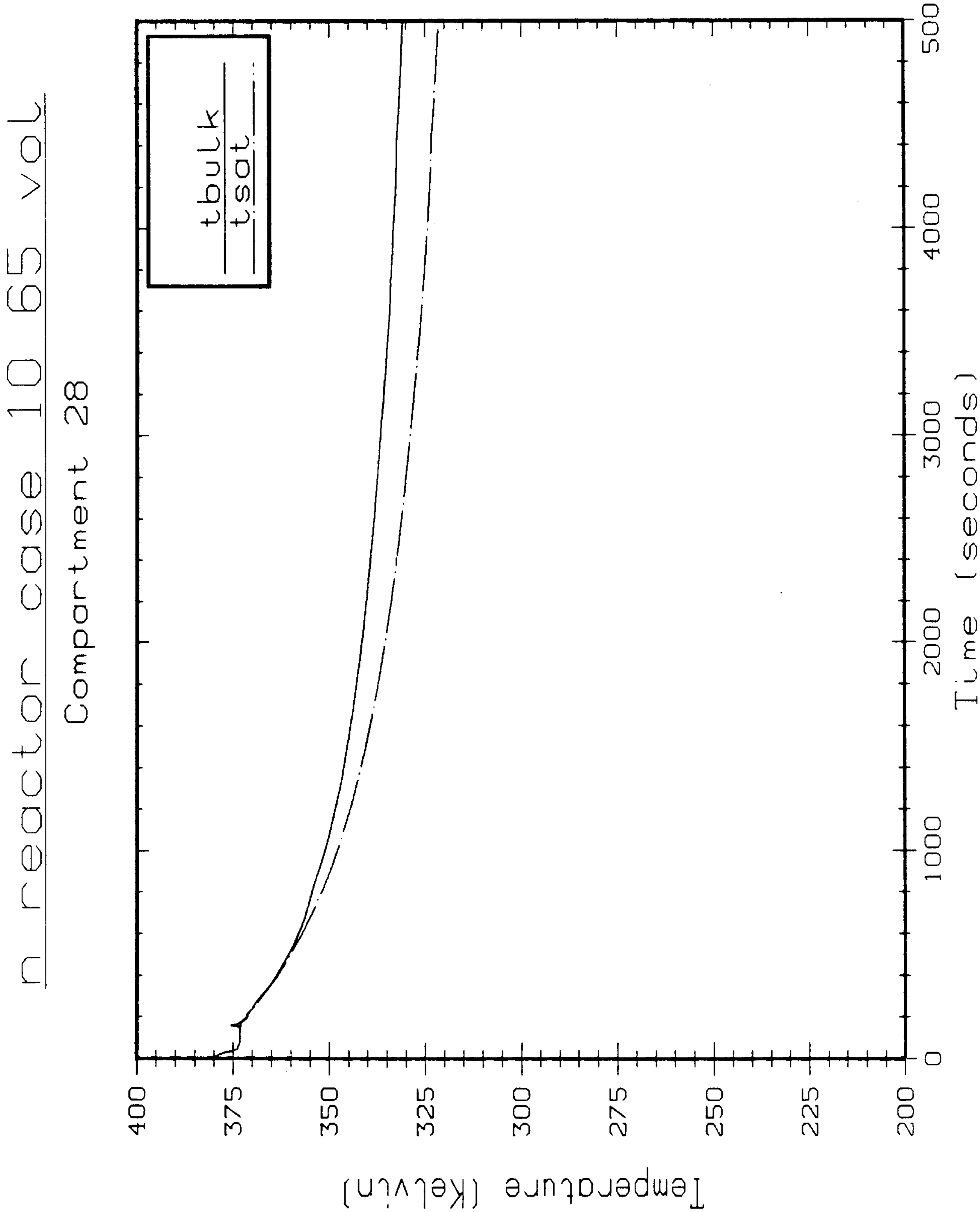

n reactor case 9 15 vol
Junction 12
Junction Area (m**2)
Time (seconds)
0
10
20
30
40
50
60
70
80
90
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

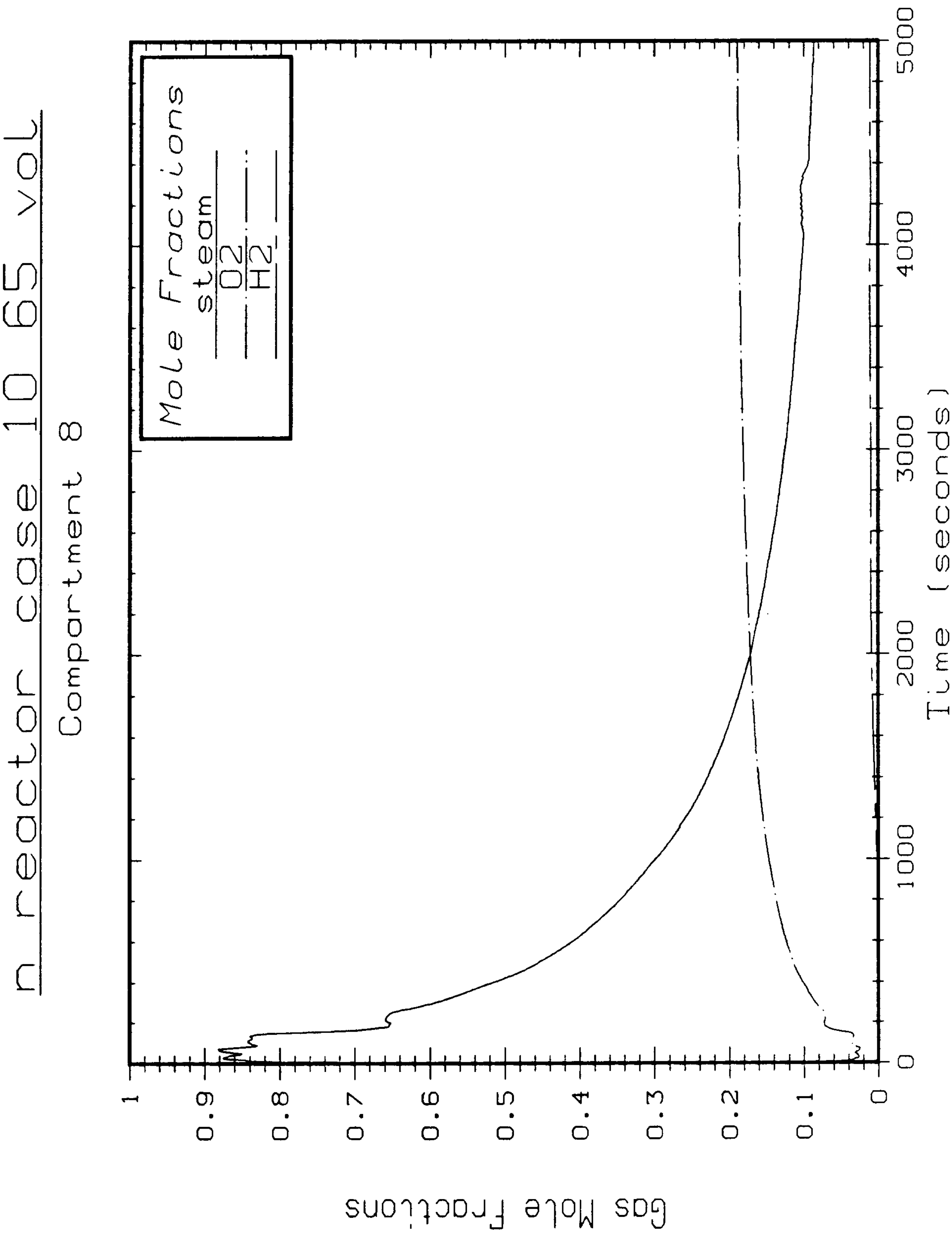

n reactor case 9 15 vol
Leakage from Leak 1
Time (seconds)
Total Gas Leaked (kg)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
5000
0
-5000
-10000
-15000
-20000
-25000
-30000
-35000
-40000
-45000

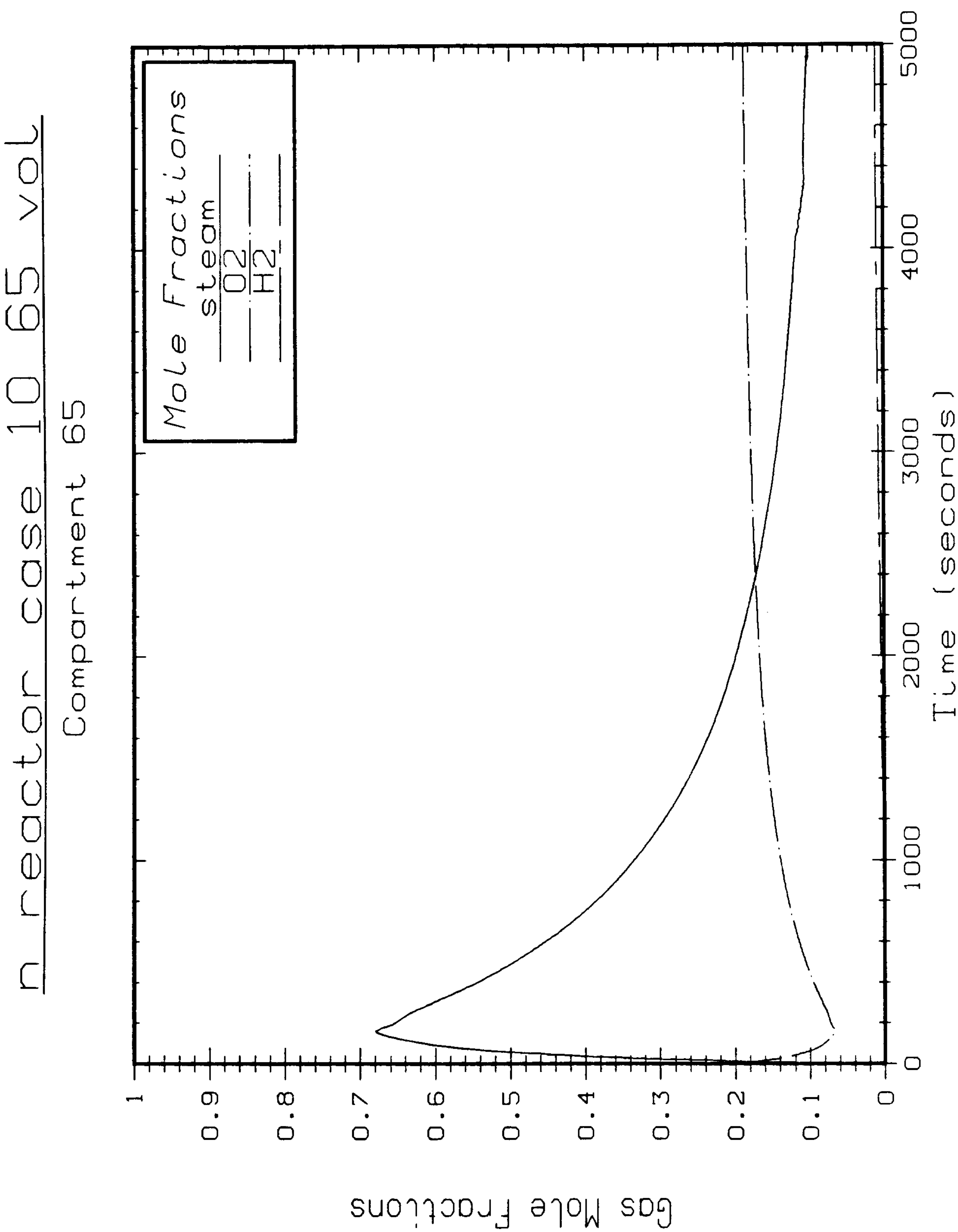
SELECTED PLOTS

CASE 10

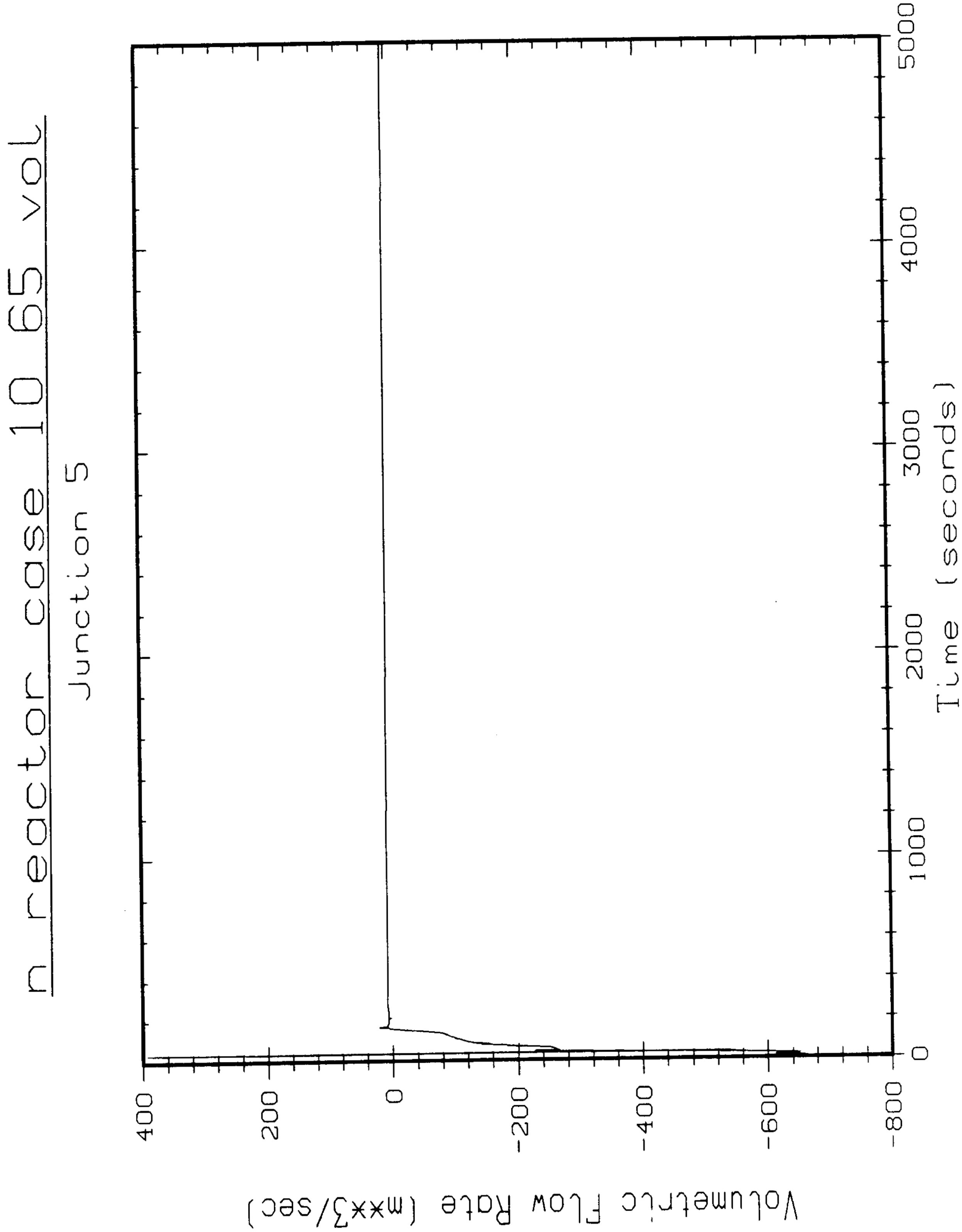

n reactor case 10 65 vol
Compartment 28
Pressure (kPa)
150
100
50
Time (seconds)
0
1000
2000
3000
4000
5000

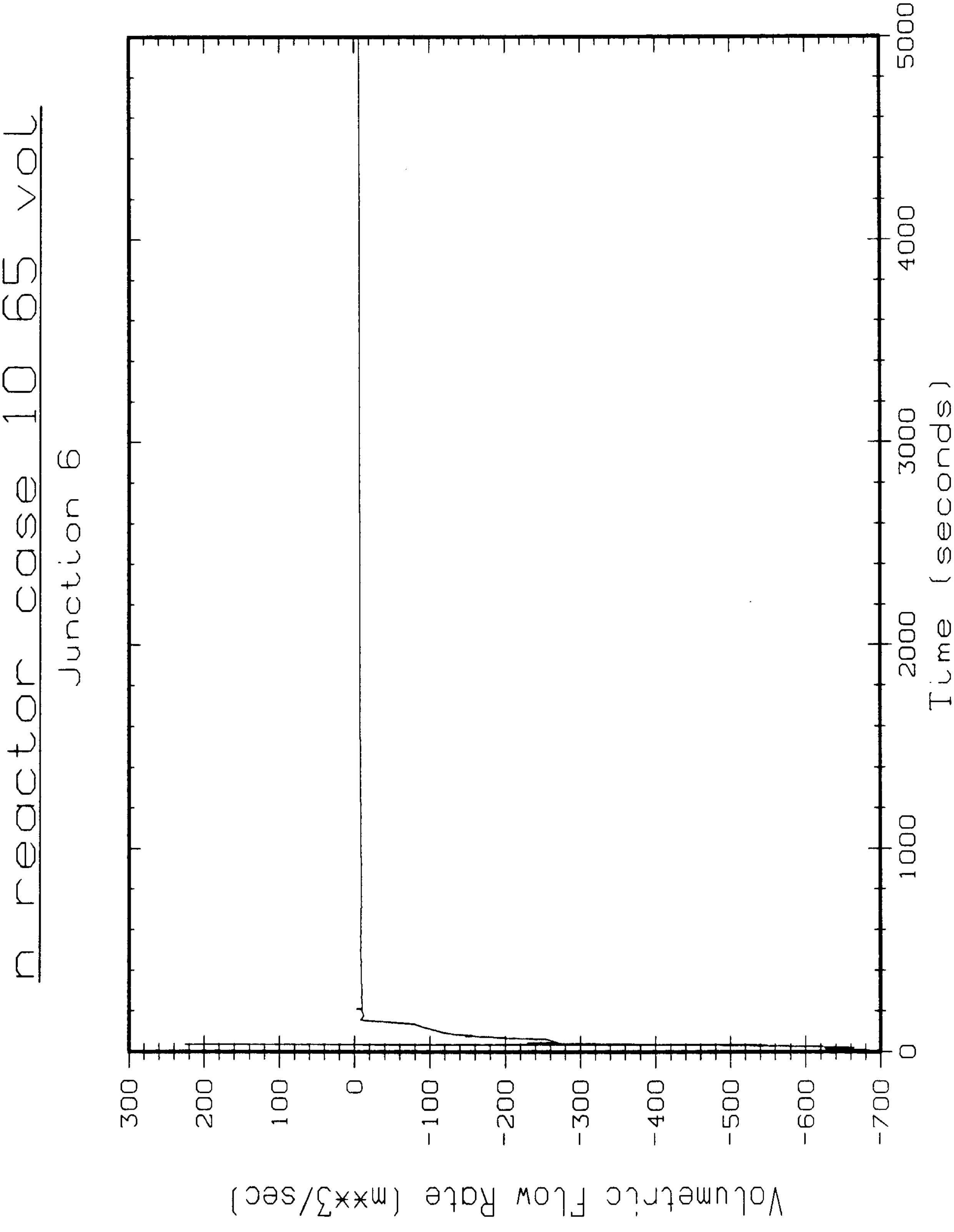

n reactor case 10 65 vol
Compartment 28
tbulk
tsat
Temperature (Kelvin)
400
375
350
325
300
275
250
225
200
Time (seconds)
0
1000
2000
3000
4000
5000


n reactor case 10 65 vol
Compartment 8
Mole Fractions
steam
O2
H2
Time (seconds)
0
1000
2000
3000
4000
5000
Gas Mole Fractions
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1



n reactor case 10 65 vol
Compartment 65
Mole Fractions
steam
O2
H2
Gas Mole Fractions
Time (seconds)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
1000
2000
3000
4000
5000


n reactor case 10 65 vol
Junction 5
Volumetric Flow Rate (m**3/sec)
400
200
0
-200
-400
-600
-800
Time (seconds)
0
1000
2000
3000
4000
5000


n reactor case 10 65 vol
Junction 6
Time (seconds)
0
1000
2000
3000
4000
5000
Volumetric Flow Rate (m**3/sec)
300
200
100
0
-100
-200
-300
-400
-500
-600
-700

APPENDIX E

INPUT DECK FOR CASE 10

(65-VOLUME MODEL)

```
! INITIAL NAMELIST TYPE INPUT
UOA = 9
CMPUTR = CRAY
$ END OF NAMELIST INPUT
!*********************************************
! PROBLEM GEOMETRY AND CONTAINMENT DESCRIPTION
!*********************************************
N REACTOR CASE 10 65 VOL$

THIS IS A 65 VOLUME DECK USED FOR SCOPING CALCULATIONS OF
COMBUSTION RESPONSE AT N REACTOR

ALL SI UNITS




65 ! NUMBER OF COMPARTMENTS
!
! FOR EACH COMPARTMENT: AN ID, THE VOLUME (M**3), ELEVATION (M), FLAME
! PROPAGATION LENGTH (M), NUMBER OF SURFACES, AND INTEGERS
! SPECIFYING WHICH SUMP TO DUMP EXCESS WATER (FROM SUPERSATURATION)
! INTO AND WHICH SUMP THE SPRAYS FALL INTO.
!
C1-FRONTRXBLD
11243.    9.9  19.8  4 1 1
C2-REARRXBLD
11543.    5.7  19.8  4 2 2
C3-PIPE-GALL-31
1810.42  0.309 7.62  3 5 5
C4-PIPE-GALL
1761.2  -2.67  16.0  3 3 3
C5-PIPE-GALL
862.34  -2.67  9.14  2 3 3
C6-PIPE-GALL
2651.55 -2.67 24.38  3 3 3
C7-PIPE-GALL
1920.1   2.38  16.0  2 3 3
C8-PIPE-GALL
1096.3   2.38  9.14  2 3 3
C9-PIPE-GALL
2922.94  2.38 24.38  2 3 3
C10-PIPE-GALL
2090.85  8.06  16.0  2 3 3
C11-PIPE-GALL
1144.58  8.06  9.14  2 3 3
C12-PIPE-GALL
3118.53  8.06 24.38  2 3 3
C13-PRES-PENT
1189.15 18.21  7.32  1 3 3
C14-AUXCELL-14C
5699.93  2.97 12.04  3 4 4
```

C15-FILTERBLD
3881. 8.35 141.3 2 0 0
C16-PG-32
78.48 6.83 2.67 2 5 5
C17-PG-33
72.29 6.83 2.67 2 5 5
C18-PG-34
72.29 6.83 2.67 2 5 5
C19-PG-35
80.46 9.55 2.67 2 5 5
C20-PG-36
75.02 9.55 2.67 2 5 5
C21-PG-37
75.02 9.55 2.67 2 5 5
C22-PG-38
84.54 6.83 2.67 2 5 5
C23-PG-39
78.34 6.83 2.67 2 5 5
C24-PG-310
78.34 6.83 2.67 2 5 5
C25-PG-311
85.02 9.52 2.67 2 5 5
C26-PG-312
79.58 9.52 2.67 2 5 5
C27-PG-313
79.58 9.52 2.67 2 5 5
C28-SG6-141
286.32 -2.41 6.04 3 5 5
C29-SG6-142
334.91 -2.41 6.04 3 5 5
C30-SG6-143
286.32 -2.41 6.04 3 5 5
C31-SG6-144
310.23 2.75 6.04 2 5 5
C32-SG6-145
337.28 2.75 6.04 2 5 5
C33-SG6-146
310.23 2.75 6.04 2 5 5
C34-SG6-147
169.74 6.83 6.04 2 5 5
C35-SG6-148
169.74 6.83 6.04 2 5 5
C36-SG6-149
169.74 6.83 6.04 2 5 5
C37-SG6-1410
166.15 9.47 6.04 2 5 5
C38-SG6-1411
166.15 9.47 6.04 2 5 5
C39-SG6-1412
166.15 9.47 6.04 2 5 5
C40-SG6-1413
237.34 -2.35 6.04 2 5 5
C41-SG6-1414

```
288.79  -2.35  6.04  2 5 5
C42-SG6-1415
237.34  -2.35  6.04  2 5 5
C43-SG6-1416
310.23  2.75  6.04  2 5 5
C44-SG6-1417
337.28  2.75  6.04  1 5 5
C45-SG6-1418
310.23  2.75  6.04  2 5 5
C46-SG6-1419
163.68  6.83  6.04  2 5 5
C47-SG6-1420
163.68  6.83  6.04  1 5 5
C48-SG6-1421
163.68  6.83  6.04  2 5 5
C49-SG6-1422
152.89  9.41  6.04  2 5 5
C50-SG6-1423
152.89  9.41  6.04  2 5 5
C51-SG6-1424
152.89  9.41  6.04  2 5 5
C52-SG6-1425
176.59  2.75  3.16  2 5 5
C53-SG6-1426
176.59  2.75  3.16  2 5 5
C54-SG6-1427
176.59  2.75  3.16  2 5 5
C55-SG6-1428
85.71  6.83  3.16  2 5 5
C56-SG6-1429
85.71  6.83  3.16  2 5 5
C57-SG6-1430
85.71  6.83  3.16  2 5 5
C58-SG6-1431
77.20  9.36  3.16  2 5 5
C59-SG6-1432
77.20  9.36  3.16  2 5 5
C60-SG6-1433
77.20  9.36  3.16  2 5 5
C61-SGCELL1-14A
6561.10  3.32  15.24  3 3 3
C62-SGCELL2-14B
6561.10  3.32  15.24  3 3 3
C63-SGCELL3-14D
6561.10  3.32  15.24  3 3 3
C64-SGCELL4-14E
6561.10  3.32  15.24  3 3 3
C65-SGCELL5-14F
6561.10  3.32  15.24  3 3 3
!
! FOR EACH SUMP: SUMP NUMBER, MAXIMUM VOLUME (M**3), SUMP NUMBER THAT
! THIS SUMP OVERFLOWS TO
!
```

```
! SUMP 1 IS UNDERNEATH THE ELEVATOR IN FRONT RX BLDG. WHEN IT FILLS
! WATER FLOWS ONTO THE FLOOR AND INTO DRAINS. IT IS REMOVED FROM THE RX
! BLDG.
1 16.9  0
! SUMP 2 IS THE BANANA WALL. IT HAS A VERY LARGE VOLUME SINCE IT
! CONNECTS TO THE FUEL POOL;HOWEVER WE NEGLECT THAT HERE AND CALCULATE
! THE VOLUME IN THE CAVITY ONLY. SINCE WHEN IT OVERFLOWS THE WATER GOES
! TO THE DRAINS AND IS REMOVED FROM THE RX BLDG, THE EFFECT IS THE SAME
! AS IF WE INCREASED THE VOLUME BUT DID NOT ADD IT TO THE ROOM VOLUME.
2 413.  0
! THERE ARE 6 SUMPS EACH OF WHICH HAS 15 M**3 OF WATER INITIALLY
! AND 234.5 M**3 OF EMPTY VOLUME FOR A TOTAL VOLUME OF 249.5 NM**3.
! THIS SUMP HAS 5 CELLS.
3 1247.5 5
! SUMP 4 IS AN ARBITRARY SUMP IN THE AUX CELL SO THAT WATER WILL NOT
! LEAVE THE SYSTEM AND THE VOLUME OF WATER WILL BE SUBTRACTED FROM THE
! AUX CELL VOLUME.
4 2000. 0
! THIS SUMP IS FOR THE CELL IN WHICH THERE IS A BREAK.
5 249.5 3
$
!
! FOR EACH SURFACE: TYPE OF SURFACE, MASS OF SURFACE (KG), AREA OF
! SURFACE (M**2), CHARACTERISTIC LENGTH (M), SPECIFIC HEAT (J/KG/K),
! EMISSIVITY, INTEGER INDICATING WHICH SUMP THE CONDENSATE GOES INTO.
! FOR SLABS (STYPE = 1), THE NUMBER OF LAYERS IN THE SURFACE, AND FOR
! EACH, THE THICKNESS (M), THERMAL DIFFUSIVITY (M**2/S), AND THERMAL
! CONDUCTIVITY (W/M/K).  FINALLY, THE NODING INFORMATION AND BOUNDARY
! CONDITIONS ARE SPECIFIED (0'S INDICATE HECTR WILL DETERMINE
! THE VALUES INTERNALLY). NOTE THAT SOME OF THE NUMBERS SET TO 1.
! ARE NOT USED FOR THAT SURFACE TYPE.
!
! C1 SURFACES
!
SUMP1
3 15000. 24.55  4.16  1. .94 1
CONC1
1 1. 4143.3 24.3  1. .9  1
1
.3 1.6E-6 2.39
0 0. 0. 0.
CONC1H
1 1. 139.8  9.1   1. .9  1
1
.3 1.6E-6 2.39
0 0. -1. 477.
STEEL1
2 333336. 1597. 1. 531.7 .7 1
!
! C2 SURFACES
!
SUMP2
3 400800. 42.6 5.03 1. .94 2
```

```
CONC2
1 1. 4438.6 24.3 1. .9 2
1
.3 1.6E-6 2.39
0 0. 0. 0.
CONC2H
1 1. 139.8 9.1 1. .9 2
1
.3 1.6E-6 2.39
0 0. -1. 505.
STEEL2
2 357665.6 1454. 1. 531.7 .7 2
!
! C3 SURFACES
!
SUMP3
3 7515. 47.38 1.83 1. .94 5
CONC3
1 1. 757.61 2.71    1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL3
2 67601.15 274.59 1. 531.7 .7 5
!
! C4 SURFACES
!
SUMP4
3 15030. 94.77 1.83 1. .94 3
CONC4
1 1. 591.6 4.42 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL4
2 137122.8 556.98 1. 531.7 .7 3
!
! C5 SURFACES
!
CONC5
1 1. 356.74 4.42 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL5
2 78355.9 318.27 1. 531.7 .7 3
!
! C6 SURFACES
!
SUMP6
3 22545. 142.15 1.83 1. .94 3
CONC6
1 1. 886.96 4.42 1. .9 3
```

```
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL6
2 208949. 848.73 1. 531.7 .7 3
!
! C7 SURFACES
!
CONC7
1 1. 526.22 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL7
2 8066. 32.76 1. 531.7 .7 3
!
! C8 SURFACES
!
CONC8
1 1. 276.43 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL8
2 4609.2 18.72 1. 531.7 .7 3
!
! C9 SURFACES
!
CONC9
1 1. 763.9 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL9
2 12291. 49.93 1. 531.7 .7 3
!
! C10 SURFACES
!
CONC10
1 1. 896.75 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL10
2 16132.1 65.53 1. 531.7 .7 3
!
! C11 SURFACES
!
CONC11
1 1. 307.1 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
```

```
STEEL11
2 9218.3 37.44 1. 531.7 .7 3
!
! C12 SURFACES
!
CONC12
1 1. 1261.63 5.68 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL12
2 24582.2 99.85 1. 531.7 .7 3
!
! C13 SURFACES
!
CONC13
1 1. 543.8 14.6 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
!
! C14 SURFACES
!
SUMP14
3 0.0   1.0  1.0 1. .94 4
CONC14
1 1. 1941.42 15.47 1. .9 4
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL14
2 160044.5 650.10 1. 531.7 .7 4
!
! C15 SURFACES
!
CONC15
1 1. 1742.7 68. 1. .94 0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL15
2 243071.5 4907.3 1. 531.7 .7 0
!
! C16 SURFACES
!
CONC16
1 1. 31.84 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL16
2 768.20 3.12 1. 531.7 .7 5
!
```

```
! C17 SURFACES
!
CONC17
1 1. 13.55 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL17
2 768.20 3.12 1. 531.7 .7 5
!
! C18 SURFACES
!
CONC18
1 1. 27.78 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL18
2 768.20 3.12 1. 531.7 .7 5
!
! C19 SURFACES
!
CONC19
1 1. 61.96 2.77 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL19
2 768.20 3.12 1. 531.7 .7 5
!
! C20 SURFACES
!
CONC20
1 1. 41.30 2.77 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL20
2 768.20 3.12 1. 531.7 .7 5
!
! C21 SURFACES
!
CONC21
1 1. 56.06 2.77 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL21
2 768.20 3.12 1. 531.7 .7 5
!
! C22 SURFACES
!
CONC22
```

```
1 1. 37.92 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL22
2 768.20 3.12 1. 531.7 .7 5
!
! C23 SURFACES
!
CONC23
1 1. 19.63 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL23
2 768.20 3.12 1. 531.7 .7 5
!
! C24 SURFACES
!
CONC24
1 1. 33.85 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL24
2 768.20 3.12 1. 531.7 .7 5
!
! C25 SURFACES
!
CONC25
1 1. 67.18 2.71 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL25
2 768.20 3.12 1. 531.7 .7 5
!
! C26 SURFACES
!
CONC26
1 1. 46.82 2.71 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL26
2 768.20 3.12 1. 531.7 .7 5
!
! C27 SURFACES
!
CONC27
1 1. 61.29 2.71 1. .9 5
1
.3 1.6E-6 2.39
```

```
0 0. 0. 0.
STEEL27
2 768.20 3.12 1. 531.7 .7 5
!
! C28 SURFACES
!
SUMP28
3 2505. 15.79 1.83 1. .94 5
CONC28
1 1. 152.22 4.82 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL28
2 14967.73 60.26 1. 531.7 .7 5
!
! C29 SURFACES
!
SUMP29
3 2505. 15.79 1.83 1. .94 5
CONC29
1 1. 73.76 4.82 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL29
2 3741.93 15.06 1. 531.7 .7 5
!
! C30 SURFACES
!
SUMP30
3 2505. 15.79 1.83 1. .94 5
CONC30
1 1. 152.22 4.82 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL30
2 14967.73 60.26 1. 531.7 .7 5
!
! C31 SURFACES
!
CONC31
1 1. 94.29 5.50 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL31
2 11225.80 45.19. 1. 531.7 .7 5
!
! C32 SURFACES
!
CONC32
```

```
1 1. 27.92 5.50 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL32
2 3741.93 15.06 1. 531.7 .7 5
!
! C33 SURFACES
!
CONC33
1 1. 94.29 5.50 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL33
2 11225.80 45.19 1. 531.7 .7 5
!
! C34 SURFACES
!
CONC34
1 1. 43.80 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL34
2 7483.86 30.13 1. 531.7 .7 5
!
! C35 SURFACES
!
CONC35
1 1. 11.68 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL35
2 3741.93 15.06 1. 531.7 .7 5
!
! C36 SURFACES
!
CONC36
1 1. 43.80 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL36
2 7483.86 30.13 1. 531.7 .7 5
!
! C37 SURFACES
!
CONC37
1 1. 104.55 2.61 1. .9 5
1
.3 1.6E-6 2.39
```

```
0 0. 0. 0.
STEEL37
2 1870.96 7.53 1. 531.7 .7 5
!
! C38 SURFACES
!
CONC38
1 1. 73.05 2.61 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL38
2 1870.96 7.53 1. 531.7 .7 5
!
! C39 SURFACES
!
CONC39
1 1. 104.55 2.61 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL39
2 1870.96 7.53 1. 531.7 .7 5
!
! C40 SURFACES
!
CONC40
1 1. 165.42 4.71 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL40
2 14967.73 60.26 1. 531.7 .7 5
!
! C41 SURFACES
!
CONC41
1 1. 84.98 4.71 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL41
2 3741.93 15.06 1. 531.7 .7 5
!
! C42 SURFACES
!
CONC42
1 1. 165.42 4.71 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL42
2 14967.73 60.26 1. 531.7 .7 5
```

```
!
! C43 SURFACES
!
CONC43
1 1. 66.37 5.50 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL43
2 11225.80 45.19 1. 531.7 .7 5
!
! C44 SURFACES
!
STEEL44
2 3741.93 15.06 1. 531.7 .7 5
!
! C45 SURFACES
!
CONC45
1 1. 66.37 5.50 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL45
2 11225.80 45.19 1. 531.7 .7 5
!
! C46 SURFACES
!
CONC46
1 1. 32.21 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL46
2 7483.86 30.13 1. 531.7 .7 5
!
! C47 SURFACES
!
STEEL47
2 3741.93 15.06 1. 531.7 .7 5
!
! C48 SURFACES
!
CONC48
1 1. 32.21 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL48
2 7483.86 30.13 1. 531.7 .7 5
!
! C49 SURFACES
!
```

```
CONC49
1 1. 91.45 2.49 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL49
2 1870.96 7.53 1. 531.7 .7 5
!
! C50 SURFACES
!
CONC50
1 1. 61.36 2.49 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL50
2 1870.96 7.53 1. 531.7 .7 5
!
! C51 SURFACES
!
CONC51
1 1. 91.45 2.49 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL51
2 1870.96 7.53 1. 531.7 .7 5
!
! C52 SURFACES
!
CONC52
1 1. 94.81 5.50 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL52
2 1870.96 7.53 1. 531.7 .7 5
!
! C53 SURFACES
!
CONC53
1 1. 60.06 5.50 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL53
2 3741.93 15.06 1. 531.7 .7 5
!
! C54 SURFACES
!
CONC54
1 1. 94.81 5.50 1. .9 5
1
```

```
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL54
2 1870.96 7.53 1. 531.7 .7 5
!
! C55 SURFACES
!
CONC55
1 1. 30.42 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL55
2 1870.96 7.53 1. 531.7 .7 5
!
! C56 SURFACES
!
CONC56
1 1. 13.55 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL56
2 1870.96 7.53 1. 531.7 .7 5
!
! C57 SURFACES
!
CONC57
1 1. 30.42 2.67 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL57
2 1870.96 7.53 1. 531.7 .7 5
!
! C58 SURFACES
!
CONC58
1 1. 59.38 2.40 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL58
2 1870.96 7.53 1. 531.7 .7 5
!
! C59 SURFACES
!
CONC59
1 1. 44.18 2.40 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL59
```

```
2 1870.96 7.53 1. 531.7 .7 5
!
! C60 SURFACES
!
CONC60
1 1. 59.38 2.40 1. .9 5
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL60
2 1870.96 7.53 1. 531.7 .7 5
!
! C61 SURFACES
!
SUMP61
3 7515. 47.38 1.83 1. .94 3
CONC61
1 1. 2144.85 15.44 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL61
2 187096.60 785.66 1. 531.7 .7 3
!
! C62 SURFACES
!
SUMP62
3 7515. 47.38 1.83 1. .94 3
CONC62
1 1. 2144.85 15.44 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL62
2 187096.60 785.66 1. 531.7 .7 3
!
! C63 SURFACES
!
SUMP63
3 7515. 47.38 1.83 1. .94 3
CONC63
1 1. 2144.85 15.44 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL63
2 187096.60 785.66 1. 531.7 .7 3
!
! C64 SURFACES
!
SUMP64
3 7515. 47.38 1.83 1. .94 3
CONC64
```

```
1 1. 2144.85 15.44 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL64
2 187096.60 785.66 1. 531.7 .7 3
!
! C65 SURFACES
!
SUMP65
3 7515. 47.38 1.83 1. .94 3
CONC65
1 1. 2144.85 15.44 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL65
2 187096.60 785.66 1. 531.7 .7 3
!
!
! CONTAINMENT LEAKAGE INFORMATION
!
! NUMBER OF LEAKS, NUMBER OF PRESSURE AND TEMPERATURE-DEPENDENT
! LEAKAGE CURVES
!
! NOL  NOP  NOT
  25    1    0
! LEAK COMPARTMENT, TEMPERATURE-DEPENDENT LEAKAGE CURVE, PRESSURE-
! DEPENDENT LEAKAGE CURVE, CONTAINMENT FAILURE FLAG, CONTAINMENT
! FAILURE CRITERION, CONTAINMENT FAILURE AREA (M**2), LEAK ELEVATION
! (M), LEAK LOSS COEFFICIENT, L/A FOR LEAK (1/M)
!
! COMP  T CURVE  P CURVE  NCF    CRIT  AREA  ZJI   FLI    LA
! FILTERED RELEASE TO OUTSIDE.
  15      0        0       1       0.  14.3  61.6  1.0    .01
! LEAKS FROM SG CELLS.
  41      0        0       1       0.  .187  -4.9  17.14 .01
  61      0        0       1       0.  .187  -4.9  17.14 .01
  62      0        0       1       0.  .187  -4.9  17.14 .01
  63      0        0       1       0.  .187  -4.9  17.14 .01
  64      0        0       1       0.  .187  -4.9  17.14 .01
  65      0        0       1       0.  .187  -4.9  17.14 .01
  14      0        0       1       0.  .187  -4.9  17.14 .01
  59      0        0       1       0.  .005  10.7  1.0    .01
  61      0        0       1       0.  .005  10.7  1.0    .01
  62      0        0       1       0.  .005  10.7  1.0    .01
  63      0        0       1       0.  .005  10.7  1.0    .01
  64      0        0       1       0.  .005  10.7  1.0    .01
  65      0        0       1       0.  .005  10.7  1.0    .01
  14      0        0       1       0.  .005  10.7  1.0    .01
! VACUUM BREAKER FOR RX BLDG.
   1      0       -1       0   -1723.  1.3   17.8  1.6    .01
! VENT OPENS AT -1723 DIFF PRESS FULL OPEN AT -3446
```

```
! REGULAR STEAM VENT IN RX BLDG C1.
  1      0          0      5  115111.  2.63  17.8  1.74  .01
! VENT CLOSES AFTER 2 IN WG PRESSURE + 150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      23     19     4      1      6      1
! LEAK FROM PG TO OUTSIDE.
  6      0          0      1       0.  .003  -4.9  1.0   .01
! REGULAR STEAM VENTS IN PG C3(2).
  19     0          0      5  115111. 5.26   10.9  3.01  .01
! VENT CLOSES AFTER 2 IN WG PRESSURE + 150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      24     19     4      1      6      1
! REGULAR STEAM VENTS IN PG C10(4).
 10      0          0      5  115111. 10.52  10.9  3.01  .01
! VENT CLOSES AFTER 2 IN WG PRESSURE + 150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      25     19     4      1      6      1
! REGULAR STEAM VENTS IN PG C12(7).
  12     0          0      5  115111. 18.41  10.9  3.01  .01
! VENT CLOSES AFTER 2 IN WG PRESSURE + 150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      26     19     4      1      6      1
! VACUUM BREAKER IN PG.
  10     0         -1      0   -1723.   1.3  10.9  1.6   .01
! LEAK FROM REAR RX BLDG.
  2      0          0      1       0.  .003  12.2  1.0   .01
! LEAK FROM FRONT RX BLDG.
  1      0          0      1       0.  .003  12.2  1.0   .01
! SPECIAL STEAM VENT IN RX BLDG.
  1      0          0      5  109941.  2.63  17.8  1.74  .01
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP   TRIP  TABLE  TABLE  TABLE  TABLE
      15     13     4      1      5      1
!
1    1
0.  10.   100.   1000.   1723.   2153.75    2584.5    3015.25   3446.  3
1.0E-8  1.0E-8 1.0E-8 1.0E-8 1.0E-8  .325     .65        .975     1.3
0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
!
! FLOW JUNCTION DATA: COMPARTMENT ID'S, TYPE OF CONNECTION, FLOW
! AREA (M**2), LOSS COEFFICIENT, L/A RATIO (1/M), RELATIVE POSITION OF
! COMPARTMENTS, AND JUNCTION ELEVATION (M).
! ADDITIONAL INFORMATION IS PROVIDED FOR JUNCTION TYPE 7.
!
! FROM FRONT TO REAR RX BLDG.
1    2    1  24.2  1.395  .01    0    17.53
! TO FILTER BLDG FROM RX BLDG (FILTER VENTS).
1   15    7  7.04 66.26  .01   0     19.74
!  OPEN TRIP  CLOSE TRIP  BLOWN TRIP  ABLOWN
```

```
       1             2             3         0.
!  OPEN TABLE  TYPE TABLE  CLOSE TABLE TYPE TABLE
       1             1             2         1
! DUCTS FROM PG TO SG&AUX CELLS.
22    34     1  7.94  1.0    .01    0     7.15
23    35     1  7.94  1.0    .01    0     7.15
24    36     1  7.94  1.0    .01    0     7.15
25    37     1  7.94  1.0    .01    0     9.21
26    38     1  7.94  1.0    .01    0     9.21
27    39     1  7.94  1.0    .01    0     9.21
10    61     1  47.66 1.0    .01    0     8.32
10    62     1  47.66 1.0    .01    0     8.32
11    14     1  47.66 1.0    .01    0     8.32
12    63     1  47.66 1.0    .01    0     8.32
12    64     1  47.66 1.0    .01    0     8.32
12    65     1  47.66 1.0    .01    0     8.32
! AUX CELL DOOR.
8   14     1  3.25  2.0   .01   0    2.98
! OPEN CROSS VENT REAR RX BLDG TO PG.
10    2     1  2.37  2.0   .01   1    15.24
! VARIABLE CROSS VENT REAR RX BLDG TO PG.
10    2     7  7.11  2.0   .01   1    15.24
!   OPEN TRIP  CLOSE TRIP  BLOWN TRIP  ABLOWN
       9            3            10        5.52
!   OPEN TABLE TYPE TABLE  CLOSE TABLE TYPE TABLE
       3            2            3          2
12    2     7  9.47  2.0   .01   1    15.24
!   OPEN TRIP  CLOSE TRIP  BLOWN TRIP  ABLOWN
       9            3            10        7.36
!   OPEN TABLE TYPE TABLE  CLOSE TABLE TYPE TABLE
       3            2            3          2
! CROSS VENT BETWEEN REAR RX BLDG  AND PG
! 16.58 IS THE FULL OPEN AREA FROM PG TO RX BLDG AND 12.88
! IS THE FULL OPEN AREA FROM RX BLDG TO PG.  15513 IS THE DP (PA)
! TO SHEAR THE PIN AND OPEN THE DOOR FROM RX BLDG TO PG.
!
! SUMP BETWEEN PG AND SG CELLS
! ELEV=-6.4M;AREA=243.24-.1728*VOL(ADDED)
! IF 18.54 M**3 ADDED THEN SUMP PUMPS START .11 M**3/S PER SG CELL
3       28            6          11.70        2.0       .01       0       -6.4
!     MIN VOL    MAX VOL   SUMP    BLOWOUT
        15        249.63      5        0
3       29            6          11.70        2.0       .01       0       -6.4
!     MIN VOL    MAX VOL   SUMP    BLOWOUT
        15        249.63      5        0
3       30            6          11.70        2.0       .01       0       -6.4
!     MIN VOL    MAX VOL   SUMP    BLOWOUT
        15        249.63      5        0
4       61            6          40.54        2.0       .01       0       -6.4
!     MIN VOL    MAX VOL   SUMP    BLOWOUT
        75        1248.17     3        0
4       62            6          40.54        2.0       .01       0       -6.4
!     MIN VOL    MAX VOL   SUMP    BLOWOUT
```

```
       75      1248.17    3       0
6      63         6         40.54       2.0      .01     0      -6.4
!    MIN VOL   MAX VOL   SUMP   BLOWOUT
       75      1248.17    3       0
6      64         6         40.54       2.0      .01     0      -6.4
!    MIN VOL   MAX VOL   SUMP   BLOWOUT
       75      1248.17    3       0
6      65         6         40.54       2.0      .01     0      -6.4
!    MIN VOL   MAX VOL   SUMP   BLOWOUT
       75      1248.17    3       0
! FULL JUNCTIONS BETWEEN VOLUMES IN PG.
4      5          1        47.15        1.0      .01     0      -2.67
5      6          1        47.15        1.0      .01     0      -2.67
4      7          1       341.41        1.0      .01     1      -.46
5      8          1       195.09        1.0      .01     1      -.46
6      9          1       520.24        1.0      .01     1      -.46
7      8          1        60.59        1.0      .01     0      2.38
8      9          1        60.59        1.0      .01     0      2.38
7      10         1       341.41        1.0      .01     1      5.22
8      11         1       195.09        1.0      .01     1      5.22
9      12         1       520.24        1.0      .01     1      5.22
10     11         1        60.59        1.0      .01     0      8.06
11     12         1        60.59        1.0      .01     0      8.06
11     13         1        84.54        1.0      .01     1      10.9
! JUNCTIONS BETWEEN 3 AND OTHER PG VOL.
3      4          1        22.9         1.0      .01     0     -2.67
3      7          1        2.96         1.0      .01     0     -0.064
3      10         1        1.67         1.0      .01     0      5.36
16     10         1        8.13         1.0      .01     0      6.83
19     10         1        7.14         1.0      .01     0      9.33
22     10         1        8.13         1.0      .01     0      6.83
25     10         1        7.14         1.0      .01     0      9.33
! NEW JUNCTIONS IN SG CELL 6
28     29         1        58.21         1.0      .01     0     -2.41
29     30         1        58.21         1.0      .01     0     -2.41
31     32         1        66.37         1.0      .01     0      2.75
43     44         1        66.37         1.0      .01     0      2.75
32     33         1        66.37         1.0      .01     0      2.75
44     45         1        66.37         1.0      .01     0      2.75
34     35         1        32.21         1.0      .01     0      6.83
46     47         1        32.21         1.0      .01     0      6.83
35     36         1        32.21         1.0      .01     0      6.83
47     48         1        32.21         1.0      .01     0      6.83
37     38         1        31.50         1.0      .01     0      9.47
38     39         1        31.50         1.0      .01     0      9.47
28     31         1        61.37         1.0      .01     1      0.0
40     43         1        61.37         1.0      .01     1      0.0
29     32         1        61.37         1.0      .01     1      0.0
41     44         1        61.37         1.0      .01     1      0.0
30     33         1        61.37         1.0      .01     1      0.0
42     45         1        61.37         1.0      .01     1      0.0
31     34         1        61.37         1.0      .01     1      5.50
43     46         1        61.37         1.0      .01     1      5.50
```

32	35	1	61.37	1.0	.01	1	5.50
44	47	1	61.37	1.0	.01	1	5.50
33	36	1	61.37	1.0	.01	1	5.50
45	48	1	61.37	1.0	.01	1	5.50
34	37	1	61.37	1.0	.01	1	8.16
46	49	1	61.37	1.0	.01	1	8.16
35	38	1	61.37	1.0	.01	1	8.16
47	50	1	61.37	1.0	.01	1	8.16
36	39	1	61.37	1.0	.01	1	8.16
48	51	1	61.37	1.0	.01	1	8.16
49	50	1	30.09	1.0	.01	0	9.41
50	51	1	30.09	1.0	.01	0	9.41
28	40	1	24.20	1.0	.01	0	-2.38
29	41	1	24.20	1.0	.01	0	-2.38
30	42	1	24.20	1.0	.01	0	-2.38
31	43	1	27.92	1.0	.01	0	2.75
32	44	1	27.92	1.0	.01	0	2.75
33	45	1	27.92	1.0	.01	0	2.75
34	46	1	13.55	1.0	.01	0	6.83
35	47	1	13.55	1.0	.01	0	6.83
36	48	1	13.55	1.0	.01	0	6.83
37	49	1	12.96	1.0	.01	0	9.44
38	50	1	12.96	1.0	.01	0	9.44
39	51	1	12.96	1.0	.01	0	9.44
52	53	1	34.76	1.0	.01	0	2.75
53	54	1	34.76	1.0	.01	0	2.75
55	56	1	16.87	1.0	.01	0	6.83
56	57	1	16.87	1.0	.01	0	6.83
58	59	1	15.19	1.0	.01	0	9.38
59	60	1	15.19	1.0	.01	0	9.38
52	55	1	32.13	1.0	.01	1	5.50
53	56	1	32.13	1.0	.01	1	5.50
54	57	1	32.13	1.0	.01	1	5.50
55	58	1	32.13	1.0	.01	1	8.16
56	59	1	32.13	1.0	.01	1	8.16
57	60	1	32.13	1.0	.01	1	8.16
43	52	1	27.92	1.0	.01	0	2.75
44	53	1	27.92	1.0	.01	0	2.75
45	54	1	27.92	1.0	.01	0	2.75
46	55	1	13.55	1.0	.01	0	6.83
47	56	1	13.55	1.0	.01	0	6.83
48	57	1	13.55	1.0	.01	0	6.83
49	58	1	12.36	1.0	.01	0	9.38
50	59	1	12.36	1.0	.01	0	9.38
51	60	1	12.36	1.0	.01	0	9.38
40	41	1	56.83	1.0	.01	0	-2.35
41	42	1	56.83	1.0	.01	0	-2.35
! NEW JUNCTIONS IN PG 3							
3	22	1	27.10	1.0	.01	1	5.50
3	23	1	27.10	1.0	.01	1	5.50
3	24	1	27.10	1.0	.01	1	5.50
3	16	1	27.10	1.0	.01	1	5.50
3	17	1	27.10	1.0	.01	1	5.50

```
3       18          1       27.10       1.0     .01     1       5.50
16      19          1       27.10       1.0     .01     1       8.16
17      20          1       27.10       1.0     .01     1       8.16
18      21          1       27.10       1.0     .01     1       8.16
22      25          1       27.10       1.0     .01     1       8.16
23      26          1       27.10       1.0     .01     1       8.16
24      27          1       27.10       1.0     .01     1       8.16
16      17          1       14.23       1.0     .01     0       6.83
17      18          1       14.23       1.0     .01     0       6.83
19      20          1       14.76       1.0     .01     0       9.55
20      21          1       14.76       1.0     .01     0       9.55
22      23          1       14.23       1.0     .01     0       6.83
23      24          1       14.23       1.0     .01     0       6.83
25      26          1       14.47       1.0     .01     0       9.52
26      27          1       14.47       1.0     .01     0       9.52
16      22          1       13.55       1.0     .01     0       6.83
17      23          1       13.55       1.0     .01     0       6.83
18      24          1       13.55       1.0     .01     0       6.83
19      25          1       13.92       1.0     .01     0       9.53
20      26          1       13.92       1.0     .01     0       9.53
21      27          1       13.92       1.0     .01     0       9.53
$ END OF JUNCTIONS
$ NO ICE CONDENSER
$ NO SUPPRESSION POOL
$ NO FANS
$ NO FAN COOLER
 !
 ! BEAM LENGTH AND VIEW FACTOR MATRICES
 !
 ! BEAM LENGTHS
 !
  6.854734      6.854734      6.854734      6.854734
 139*0.0
  6.854734      6.854734      6.854734
 139*0.0
  6.854734      6.854734
 139*0.0
  6.854734
 139*0.0
  6.840296      6.840296      6.840296      6.840296
 135*0.0
  6.840296      6.840296      6.840296
 135*0.0
  6.840296      6.840296
 135*0.0
  6.840296
 135*0.0
  6.037082      6.037082      6.037082
 132*0.0
  6.037082      6.037082
 132*0.0
  6.037082
 132*0.0
```

5.099385	5.099385	5.099385
129*0.0		
5.099385	5.099385	
129*0.0		
5.099385		
129*0.0		
4.599079	4.599079	
127*0.0		
4.599079		
127*0.0		
5.083277	5.083277	5.083277
124*0.0		
5.083277	5.083277	
124*0.0		
5.083277		
124*0.0		
12.36602	12.36602	
122*0.0		
12.36602		
122*0.0		
13.37178	13.37178	
120*0.0		
13.37178		
120*0.0		
12.92971	12.92971	
118*0.0		
12.92971		
118*0.0		
7.822110	7.822110	
116*0.0		
7.822110		
116*0.0		
11.95939	11.95939	
114*0.0		
11.95939		
114*0.0		
8.245959	8.245959	
112*0.0		
8.245959		
112*0.0		
7.872269		
111*0.0		
7.915043	7.915043	7.915043
108*0.0		
7.915043	7.915043	
108*0.0		
7.915043		
108*0.0		
2.100992	2.100992	
106*0.0		
2.100992		
106*0.0		
8.081465	8.081465	

```
104*0.0
  8.081465
104*0.0
  15.61152       15.61152
102*0.0
  15.61152
102*0.0
  8.422135       8.422135
100*0.0
  8.422135
100*0.0
  4.450768       4.450768
 98*0.0
  4.450768
 98*0.0
  6.079964       6.079964
 96*0.0
  6.079964
 96*0.0
  4.563569       4.563569
 94*0.0
  4.563569
 94*0.0
  7.415790       7.415790
 92*0.0
  7.415790
 92*0.0
  12.39666       12.39666
 90*0.0
  12.39666
 90*0.0
  7.628456       7.628456
 88*0.0
  7.628456
 88*0.0
  4.353798       4.353798
 86*0.0
  4.353798
 86*0.0
  5.736644       5.736644
 84*0.0
  5.736644
 84*0.0
  4.447881       4.447881
 82*0.0
  4.447881
 82*0.0
  4.515495       4.515495       4.515495
 79*0.0
  4.515495       4.515495
 79*0.0
  4.515495
 79*0.0
```

```
 11.52544       11.52544       11.52544
76*0.0
 11.52544       11.52544
76*0.0
 11.52544
76*0.0
 4.515495       4.515495       4.515495
73*0.0
 4.515495       4.515495
73*0.0
 4.515495
73*0.0
 8.007084       8.007084
71*0.0
 8.007084
71*0.0
 28.25054       28.25054
69*0.0
 28.25054
69*0.0
 8.007084       8.007084
67*0.0
 8.007084
67*0.0
 8.265441       8.265441
65*0.0
 8.265441
65*0.0
 22.85206       22.85206
63*0.0
 22.85206
63*0.0
 8.265441       8.265441
61*0.0
 8.265441
61*0.0
 5.336723       5.336723
59*0.0
 5.336723
59*0.0
 7.422933       7.422933
57*0.0
 7.422933
57*0.0
 5.336723       5.336723
55*0.0
 5.336723
55*0.0
 3.785998       3.785998
53*0.0
 3.785998
53*0.0
 10.39228       10.39228
```

```
51*0.0
 10.39228
51*0.0
 3.785998          3.785998
49*0.0
 3.785998
49*0.0
 10.01101          10.01101
47*0.0
 10.01101
47*0.0
 56.72031
46*0.0
 10.01101          10.01101
44*0.0
 10.01101
44*0.0
 9.452166          9.452166
42*0.0
 9.452166
42*0.0
 39.12669
41*0.0
 9.452166          9.452166
39*0.0
 9.452166
39*0.0
 5.560760          5.560760
37*0.0
 5.560760
37*0.0
 7.989606          7.989606
35*0.0
 7.989606
35*0.0
 5.560760          5.560760
33*0.0
 5.560760
33*0.0
 6.211882          6.211882
31*0.0
 6.211882
31*0.0
 8.462779          8.462779
29*0.0
 8.462779
29*0.0
 6.211882          6.211882
27*0.0
 6.211882
27*0.0
 8.130592          8.130592
25*0.0
```

```
 8.130592
25*0.0
 14.63738        14.63738
23*0.0
 14.63738
23*0.0
 8.130592        8.130592
21*0.0
 8.130592
21*0.0
 4.153639        4.153639
19*0.0
 4.153639
19*0.0
 5.374589        5.374589
17*0.0
 5.374589
17*0.0
 4.153639        4.153639
15*0.0
 4.153639
15*0.0
 7.931777        7.931777        7.931777
12*0.0
 7.931777        7.931777
12*0.0
 7.931777
12*0.0
 7.931777        7.931777        7.931777
 9*0.0
 7.931777        7.931777
 9*0.0
 7.931777
 9*0.0
 7.931777        7.931777        7.931777
 6*0.0
 7.931777        7.931777
 6*0.0
 7.931777
 6*0.0
 7.931777        7.931777        7.931777
 3*0.0
 7.931777        7.931777
 3*0.0
 7.931777
 3*0.0
 7.931777        7.931777        7.931777
 7.931777        7.931777
 7.931777
!
! VIEW FACTORS
!
 0.0000000E+00  0.7046309       2.3775108E-02  0.2715940
```

```
139*0.0
 0.7016890       2.3675844E-02  0.2704601
139*0.0
 2.3675842E-02  0.2704601
139*0.0
 0.2704601
139*0.0
 0.0000000E+00  0.7357934       2.3174856E-02  0.2410318
135*0.0
 0.7305974       2.3011198E-02  0.2393296
135*0.0
 2.3011200E-02  0.2393296
135*0.0
 0.2393296
135*0.0
 0.0000000E+00  0.7339760       0.2660240
132*0.0
 0.7002851       0.2538130
132*0.0
 0.2538130
132*0.0
 0.0000000E+00  0.5150708       0.4849292
129*0.0
 0.4725720       0.4449174
129*0.0
 0.4449174
129*0.0
 0.5284958       0.4715041
127*0.0
 0.4715042
127*0.0
 0.0000000E+00  0.5110129       0.4889871
124*0.0
 0.4691618       0.4489399
124*0.0
 0.4489399
124*0.0
 0.9413933       5.8606748E-02
122*0.0
 5.8606744E-02
122*0.0
 0.9365746       6.3425377E-02
120*0.0
 6.3425362E-02
120*0.0
 0.9386481       6.1351877E-02
118*0.0
 6.1351895E-02
118*0.0
 0.9319013       6.8098679E-02
116*0.0
 6.8098724E-02
116*0.0
```

```
 0.8913333       0.1086666
114*0.0
 0.1086667
114*0.0
 0.9266607       7.3339306E-02
112*0.0
 7.3339343E-02
112*0.0
  1.000000
111*0.0
 0.0000000E+00   0.7491415       0.2508586
108*0.0
 0.7488524       0.2507618
108*0.0
 0.2507617
108*0.0
 0.2620601       0.7379398
106*0.0
 0.7379399
106*0.0
 0.9107552       8.9244850E-02
104*0.0
 8.9244843E-02
104*0.0
 0.8128374       0.1871626
102*0.0
 0.1871626
102*0.0
 0.8990291       0.1009709
100*0.0
 0.1009709
100*0.0
 0.9520590       4.7940992E-02
 98*0.0
 4.7941089E-02
 98*0.0
 0.9297614       7.0238635E-02
 96*0.0
 7.0238590E-02
 96*0.0
 0.9472795       5.2720513E-02
 94*0.0
 5.2720487E-02
 94*0.0
 0.9239766       7.6023392E-02
 92*0.0
 7.6023400E-02
 92*0.0
 0.8628571       0.1371429
 90*0.0
 0.1371429
 90*0.0
 0.9156073       8.4392756E-02
```

88*0.0		
8.4392726E-02		
88*0.0		
0.9556187	4.4381220E-02	
86*0.0		
4.4381201E-02		
86*0.0		
0.9375250	6.2474970E-02	
84*0.0		
6.2474966E-02		
84*0.0		
0.9515603	4.8439678E-02	
82*0.0		
4.8439741E-02		
82*0.0		
0.0000000E+00	0.7163969	0.2836032
79*0.0		
0.6631594	0.2625278	
79*0.0		
0.2625278		
79*0.0		
0.0000000E+00	0.8304436	0.1695564
76*0.0		
0.6828113	0.1394135	
76*0.0		
0.1394135		
76*0.0		
0.0000000E+00	0.7163969	0.2836032
73*0.0		
0.6631594	0.2625278	
73*0.0		
0.2625278		
73*0.0		
0.6760109	0.3239891	
71*0.0		
0.3239892		
71*0.0		
0.6496045	0.3503956	
69*0.0		
0.3503955		
69*0.0		
0.6760109	0.3239891	
67*0.0		
0.3239892		
67*0.0		
0.5924523	0.4075477	
65*0.0		
0.4075477		
65*0.0		
0.4367988	0.5632012	
63*0.0		
0.5632012		
63*0.0		

0.5924523	0.4075477
61*0.0	
0.4075477	
61*0.0	
0.9328158	6.7184158E-02
59*0.0	
6.7184091E-02	
59*0.0	
0.9065525	9.3447506E-02
57*0.0	
9.3447447E-02	
57*0.0	
0.9328158	6.7184158E-02
55*0.0	
6.7184091E-02	
55*0.0	
0.7329848	0.2670152
53*0.0	
0.2670152	
53*0.0	
0.8494602	0.1505398
51*0.0	
0.1505398	
51*0.0	
0.7329848	0.2670152
49*0.0	
0.2670152	
49*0.0	
0.5949265	0.4050735
47*0.0	
0.4050735	
47*0.0	
1.000000	
46*0.0	
0.5949265	0.4050735
44*0.0	
0.4050735	
44*0.0	
0.5166827	0.4833173
42*0.0	
0.4833173	
42*0.0	
1.000000	
41*0.0	
0.5166827	0.4833173
39*0.0	
0.4833173	
39*0.0	
0.9239240	7.6075979E-02
37*0.0	
7.6075971E-02	
37*0.0	
0.8906953	0.1093047

```
35*0.0
0.1093047
35*0.0
0.9239240     7.6075979E-02
33*0.0
7.6075971E-02
33*0.0
0.9264218     7.3578276E-02
31*0.0
7.3578179E-02
31*0.0
0.7995207     0.2004792
29*0.0
0.2004793
29*0.0
0.9264218     7.3578276E-02
27*0.0
7.3578179E-02
27*0.0
0.8015810     0.1984190
25*0.0
0.1984190
25*0.0
0.6427894     0.3572106
23*0.0
0.3572106
23*0.0
0.8015810     0.1984190
21*0.0
0.1984190
21*0.0
0.8874607     0.1125392
19*0.0
0.1125393
19*0.0
0.8543802     0.1456198
17*0.0
0.1456198
17*0.0
0.8874607     0.1125392
15*0.0
0.1125393
15*0.0
0.0000000E+00 0.7319034     0.2680967
12*0.0
0.7200701     0.2637621
12*0.0
0.2637622
12*0.0
0.0000000E+00 0.7319034     0.2680967
 9*0.0
0.7200701     0.2637621
 9*0.0
```

```
  0.2637622
   9*0.0
  0.0000000E+00  0.7319034      0.2680967
   6*0.0
  0.7200701      0.2637621
   6*0.0
  0.2637622
   6*0.0
  0.0000000E+00  0.7319034      0.2680967
   3*0.0
  0.7200701      0.2637621
   3*0.0
  0.2637622
   3*0.0
  0.0000000E+00  0.7319034      0.2680967
  0.7200701      0.2637621
  0.2637622
!
! NUMBER OF SPRAY TRAINS
2
! FOR TRAIN 1 (IN RX BLDG C1 AND C2).
!
! NUMBER OF SOURCE COMPARTMENTS
2
! SOURCE COMPARTMENT, INJECTION TEMPERATURE (K), FLOW RATE (M**3/S),
! NUMBER OF DROP SIZES; FOR EACH DROP SIZE: FREQUENCY AND DIAMETER
! (MICRONS)
1 293.15 .26  2
.49   1400.
.51   1100.
!
2 293.15 .28  2
.65   1400.
.35   1100.
! FOR SPRAY CARRYOVER, THE SOURCE AND RECEIVING COMPARTMENTS AND THE
! FRACTION CARRIED OVER
!
$
! SPRAY COMPARTMENT AND SPRAY FALL HEIGHT (M)
1  12.65
2  24.1
$
!
! SPRAY ACTUATION CRITERIA FOR THIS TRAIN
!
! NUMBER OF TOP-LEVEL CRITERIA IN "OR" CONFIGURATION
2
! FOR EACH TOP CRITERIA, NUMBER OF 2ND-LEVEL CRITERIA IN "AND"
! CONFIGURATION, AND FOR EACH 2ND-LEVEL CRITERION,
! NUMBER OF COMPARTMENTS TO TEST AND, FOR EACH
! COMPARTMENT TO TEST, THE COMPARTMENT ID AND THE PRESSURE (PA)
! AND TEMPERATURE (K) SETPOINTS.  FINALLY, THE NUMBER OF
! COMPARTMENTS THAT MUST MEET THE SETPOINTS FOR THE CRITERIA
```

```
! TO BE MET
!
! TEST COMPARTMENT 1 AND 2 AND ACTUATE IF EITHER IS TRUE "OR".
!
! TEST COMPARTMENT 1 FOR 10 IN WG.
1
1
1 103813.3 0.
1
! TEST COMPARMENT 2 FOR 10 IN WG.
1
1
2 103813.3 0.
1
!
! DELAY TIME FOR SPRAYS TO START AFTER ACTUATION AND TIME FOR
! SPRAYS TO RUN AFTER STARTING
44. 1.0E10
!
! FOR TRAIN 2 (IN PG C3,C10,C11, AND C12).
!
! NUMBER OF SOURCE COMPARTMENTS
9
! SOURCE COMPARTMENT, INJECTION TEMPERATURE (K), FLOW RATE (M**3/S),
! NUMBER OF DROP SIZES; FOR EACH DROP SIZE: FREQUENCY AND DIAMETER
! (MICRONS)
19  293.15  .001267  1
1.0  1690.
20  293.15  .001267  1
1.0  1690.
21  293.15  .001267  1
1.0  1690.
25  293.15  .001267  1
1.0  1690.
26  293.15  .001267  1
1.0  1690.
27  293.15  .001267  1
1.0  1690.
!
10 293.15  .022   1
1.0  1690.
!
11 293.15  .0126  1
1.0  1690.
!
12 293.15  .0337  1
1.0  1690.
! FOR SPRAY CARRYOVER, THE SOURCE AND RECEIVING COMPARTMENTS AND THE
! FRACTION CARRIED OVER
!
19   16   1.0
20   17   1.0
21   18   1.0
```

```
25   22   1.0
26   23   1.0
27   24   1.0
16    3   1.0
17    3   1.0
18    3   1.0
22    3   1.0
23    3   1.0
24    3   1.0
10    7   1.0
7     4   1.0
11    8   1.0
8     5   1.0
12    9   1.0
9     6   1.0
$
! SPRAY COMPARTMENT AND SPRAY FALL HEIGHT (M)
3   10.37
16  2.67
17  2.67
18  2.67
19  2.77
20  2.77
21  2.77
22  2.67
23  2.67
24  2.67
25  2.71
26  2.71
27  2.71
4  4.42
5  4.42
6  4.42
7  5.68
8  5.68
9  5.68
10 5.68
11 5.68
12 5.68
$
!
! SPRAY ACTUATION CRITERIA FOR THIS TRAIN
!
! NUMBER OF CRITERIA IN "OR" CONFIGURATION
1
! FOR EACH TOP CRITERIA, NUMBER OF 2ND-LEVEL CRITERIA IN "AND"
! CONFIGURATION, AND FOR EACH 2ND-LEVEL CRITERION,
! NUMBER OF COMPARTMENTS TO TEST AND, FOR EACH
! COMPARTMENT TO TEST, THE COMPARTMENT ID AND THE PRESSURE (PA)
! AND TEMPERATURE (K) SETPOINTS.  FINALLY, THE NUMBER OF
! COMPARTMENTS THAT MUST MEET THE SETPOINTS FOR THE CRITERIA
! TO BE MET
! TEST PG AND SG CELLS FOR 10 IN WG.
```

```
2
!
! TEST PG COMP 10 "OR" 12 FOR 10 IN WG.
2
10 103813.3 0.
12 103813.3 0.
1
! TEST SG CELLS FOR 10 IN WG.
6
50 103813.3 0.
61 103813.3 0.
62 103813.3 0.
63 103813.3 0.
64 103813.3 0.
65 103813.3 0.
1
!
! DELAY TIME FOR SPRAYS TO START AFTER ACTUATION AND TIME FOR
! SPRAYS TO RUN AFTER STARTING
44.  1.0E10
! SPRAY HEAT EXCHANGER INFORMATION
$ NO SPRAY RECIRC
$ NO SUMP HEAT EXCHANGERS
!
2500.    500.     ! SIMULATION TIME AND CPU  TIME REMAINING
!
! INITIAL CONDITIONS
!
! TBULK, PP(1-4), UX
! TEMP  STEAM     N2      O2      H    CONV GAS VEL
  339.  20500. 63850. 16975.   0.       .3
  339.  20500. 63850. 16975.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
  322.  9350.   72660. 19315.   0.       .3
```

```
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
  322.  9350.  72660. 19315.   0.     .3
!
! INITIAL CONDITIONS FOR LEAKS
! TATM, PPATM(1-4)
300.  2798. 77836. 20691. 0.
!
! SOURCE DATA
!
! STEAM AND WATER
! COMP, -1 = CONST. SOURCE T, TEMP, SSRCC
  44             3                477.   0
! TIME    RATE     ENTHAPY
```

0.0	0.0	9.0156E5
0.1	16349.2	8.9179E5
0.2	17620.2	8.9225E5
0.4	18327.8	8.9272E5
0.6	18465.6	8.9272E5
1.0	18293.3	8.9295E5
1.5	18282.4	8.9318E5
2.0	18141.8	8.9388E5
3.0	17964.4	8.9807E5
5.0	17190.2	9.2714E5
6.0	17003.3	9.5343E5
7.0	16060.7	9.8529E5
8.0	14970.3	1.0188E6
9.0	14533.0	1.0516E6
10.0	13689.3	1.0814E6
12.0	11281.7	1.1290E6
15.0	9411.10	1.1737E6
20.0	8951.10	1.2221E6
25.0	7414.40	1.2560E6
30.0	5597.30	1.2837E6
35.0	3980.70	1.3405E6
40.0	2624.50	1.4593E6
43.6	1808.00	1.4763E6
45.0	2296.10	1.3707E6
48.4	3859.10	1.0623E6
50.0	4327.20	9.9739E5
55.0	4388.00	9.7645E5
59.0	4201.20	9.6901E5
60.0	3568.80	1.0439E6
62.0	3632.30	1.0123E6
64.0	2805.00	1.1265E6
66.0	2339.60	1.2023E6
70.0	1996.70	1.2288E6
75.0	983.400	1.7184E6
78.0	1219.30	1.4335E6
80.0	1246.50	1.4882E6
84.0	743.000	1.9273E6
87.0	825.530	1.7368E6
90.0	840.050	1.6582E6
93.0	844.580	1.5896E6
99.0	879.060	1.4775E6
106.0	876.790	1.4233E6
112.0	808.300	1.4570E6
118.0	702.160	1.5145E6
124.0	699.440	1.5545E6
134.0	361.060	2.4214E6
145.0	146.060	2.6633E6
150.0	64.4100	2.6865E6
156.0	10.8860	2.7028E6
156.5	0.0	2.7028E6
3600.0	0.0	2.7028E6

$
$

```
! NITROGEN
$
! OXYGEN
$
! HYDROGEN
! COMP, -1 = CONST. SOURCE T, TEMP, SSRCC
!   28          -1                  1311.   0
    44          -1                   477.   0
!      TIME           RATE
  +0.00000E+00, +0.00000E+00
  +1.60000E+02, +4.60000E-04
  +3.20000E+02, +9.20000E-04
  +4.80000E+02, +3.22000E-03
  +5.60000E+02, +1.10400E-02
  +6.40000E+02, +2.02400E-02
  +7.20000E+02, +3.31200E-02
  +8.00000E+02, +4.78400E-02
  +8.32000E+02, +5.15200E-02
  +8.80000E+02, +4.23200E-02
  +9.60000E+02, +3.49600E-02
  +1.12000E+03, +2.76000E-02
  +1.28000E+03, +2.24480E-02
  +1.44000E+03, +1.87680E-02
  +1.60000E+03, +1.69280E-02
  +1.76000E+03, +1.47200E-02
  +1.92000E+03, +1.32480E-02
  +2.08000E+03, +1.19600E-02
  +2.24000E+03, +1.08560E-02
  +2.40000E+03, +9.93600E-03
  +2.56000E+03, +9.01600E-03
  +2.72000E+03, +8.64800E-03
  +2.88000E+03, +8.28000E-03
  +3.04000E+03, +8.09600E-03
  +3.20000E+03, +7.91200E-03
  +3.36000E+03, +7.54400E-03
  +3.52000E+03, +7.36000E-03
  +3.68000E+03, +7.17600E-03
  +3.84000E+03, +6.99200E-03
  +4.00000E+03, +6.90000E-03
  +4.16000E+03, +6.80800E-03
  +4.32000E+03, +6.62400E-03
  +4.48000E+03, +6.44000E-03
  +4.64000E+03, +6.25600E-03
  +4.80000E+03, +5.98000E-03
  +4.96000E+03, +5.98000E-03
  +5.12000E+03, +5.88800E-03
  +5.28000E+03, +5.70400E-03
  +5.44000E+03, +5.61200E-03
  +5.60000E+03, +5.56600E-03
  +5.76000E+03, +5.56600E-03
  +5.92000E+03, +5.54300E-03
  +6.08000E+03, +5.52000E-03
  +6.24000E+03, +5.42800E-03
```

```
  +6.40000E+03, +5.33600E-03
  +6.56000E+03, +5.24400E-03
  +6.72000E+03, +5.15200E-03
  +6.88000E+03, +5.15200E-03
  +7.04000E+03, +5.06000E-03
  +7.20000E+03, +4.96800E-03
  +7.36000E+03, +4.78400E-03
  +7.52000E+03, +4.69200E-03
  +7.68000E+03, +4.60000E-03
  +7.84000E+03, +4.50800E-03
  +8.00000E+03, +4.41600E-03
  +8.16000E+03, +4.04800E-03
  +8.32000E+03, +3.95600E-03
  +8.48000E+03, +3.86400E-03
  +8.64000E+03, +3.77200E-03
  +8.80000E+03, +3.68000E-03
  +8.96000E+03, +3.58800E-03
  +9.12000E+03, +3.49600E-03
  +9.28000E+03, +3.40400E-03
  +9.44000E+03, +3.31200E-03
  +9.60000E+03, +3.31200E-03
  +9.76000E+03, +3.22000E-03
  +9.92000E+03, +3.12800E-03
  +1.00800E+04, +2.94400E-03
  +1.02400E+04, +2.76000E-03
  +1.04000E+04, +2.66800E-03
  +1.05600E+04, +2.57600E-03
  +1.07200E+04, +2.39200E-03
  +1.08800E+04, +2.30000E-03
  +1.10400E+04, +2.20800E-03
  +1.12000E+04, +2.11600E-03
  +1.13600E+04, +2.02400E-03
  +1.15200E+04, +1.93200E-03
  +1.16800E+04, +1.84000E-03
  +1.18400E+04, +1.74800E-03
  +1.20000E+04, +1.65600E-03
  +1.21600E+04, +1.56400E-03
  +1.23200E+04, +1.47200E-03
  +1.24800E+04, +1.38000E-03
  +1.26400E+04, +1.28800E-03
  +1.28000E+04, +1.19600E-03
  +1.29600E+04, +1.10400E-03
$
! DOUBLE HYDROGEN RATE FOR SENSITIVITY.
! HYDROGEN
! COMP, -1 = CONST. SOURCE T, TEMP, SSRCC
!  28          -1                  1311.    0
!  28          -1                   477.    0
!     TIME              RATE
!  +0.00000E+00, +0.00000E+00
!  +1.60000E+02, +9.20000E-04
!  +3.20000E+02, +1.84000E-03
!  +4.80000E+02, +6.44000E-03
```

```
! +5.60000E+02, +2.20800E-02
! +6.40000E+02, +4.04800E-02
! +7.20000E+02, +6.62400E-02
! +8.00000E+02, +9.56800E-02
! +8.32000E+02, +1.03040E-01
! +8.80000E+02, +8.46400E-02
! +9.60000E+02, +6.99200E-02
! +1.12000E+03, +5.52000E-02
! +1.28000E+03, +4.48960E-02
! +1.44000E+03, +3.75360E-02
! +1.60000E+03, +3.38560E-02
! +1.76000E+03, +2.94400E-02
! +1.92000E+03, +2.64960E-02
! +2.08000E+03, +2.39200E-02
! +2.24000E+03, +2.17120E-02
! +2.40000E+03, +1.98720E-02
! +2.56000E+03, +1.80320E-02
! +2.72000E+03, +1.72960E-02
! +2.88000E+03, +1.65600E-02
! +3.04000E+03, +1.61920E-02
! +3.20000E+03, +1.58240E-02
! +3.36000E+03, +1.50880E-02
! +3.52000E+03, +1.47200E-02
! +3.68000E+03, +1.43520E-02
! +3.84000E+03, +1.39840E-02
! +4.00000E+03, +1.38000E-02
! +4.16000E+03, +1.36160E-02
! +4.32000E+03, +1.32480E-02
! +4.48000E+03, +1.28800E-02
! +4.64000E+03, +1.25120E-02
! +4.80000E+03, +1.19600E-02
! +4.96000E+03, +1.19600E-02
! +5.12000E+03, +1.17760E-02
! +5.28000E+03, +1.14080E-02
! +5.44000E+03, +1.12240E-02
! +5.60000E+03, +1.11320E-02
! +5.76000E+03, +1.11320E-02
! +5.92000E+03, +1.10860E-02
! +6.08000E+03, +1.10400E-02
! +6.24000E+03, +1.08560E-02
! +6.40000E+03, +1.06720E-02
! +6.56000E+03, +1.04880E-02
! +6.72000E+03, +1.03040E-02
! +6.88000E+03, +1.03040E-02
! +7.04000E+03, +1.01200E-02
! +7.20000E+03, +9.93600E-03
! +7.36000E+03, +9.56800E-03
! +7.52000E+03, +9.38400E-03
! +7.68000E+03, +9.20000E-03
! +7.84000E+03, +9.01600E-03
! +8.00000E+03, +8.83200E-03
! +8.16000E+03, +8.09600E-03
! +8.32000E+03, +7.91200E-03
```

```
!   +8.48000E+03, +7.72800E-03
!   +8.64000E+03, +7.54400E-03
!   +8.80000E+03, +7.36000E-03
!   +8.96000E+03, +7.17600E-03
!   +9.12000E+03, +6.99200E-03
!   +9.28000E+03, +6.80800E-03
!   +9.44000E+03, +6.62400E-03
!   +9.60000E+03, +6.62400E-03
!   +9.76000E+03, +6.44000E-03
!   +9.92000E+03, +6.25600E-03
!   +1.00800E+04, +5.88800E-03
!   +1.02400E+04, +5.52000E-03
!   +1.04000E+04, +5.33600E-03
!   +1.05600E+04, +5.15200E-03
!   +1.07200E+04, +4.78400E-03
!   +1.08800E+04, +4.60000E-03
!   +1.10400E+04, +4.41600E-03
!   +1.12000E+04, +4.23200E-03
!   +1.13600E+04, +4.04800E-03
!   +1.15200E+04, +3.86400E-03
!   +1.16800E+04, +3.68000E-03
!   +1.18400E+04, +3.49600E-03
!   +1.20000E+04, +3.31200E-03
!   +1.21600E+04, +3.12800E-03
!   +1.23200E+04, +2.94400E-03
!   +1.24800E+04, +2.76000E-03
!   +1.26400E+04, +2.57600E-03
!   +1.28000E+04, +2.39200E-03
!   +1.29600E+04, +2.20800E-03
!$
$
$ NO WATER REMOVAL FROM SUMPS
$ NO COMPARTMENT ENERGY SOURCES
$ NO CONTINUOUS BURNING COMPARTMENTS
!
! TRIP LOGIC FOR JUNCTIONS
!
! FALSE TRIP SET TO FALSE AT -10 SEC.
! TRIP  TYPE  LOCK IN   NUM TESTS
   3     -4      1          1
!  TIME  TEST
!   TRIP TEST   TIME
        0        -10.
$
! PRESSURE CHECK 2 IN WG IN RX BLDG C1 & C2 "OR" LOGIC.
! TRIP  TYPE  LOCK IN   NUM TESTS
   4     1       2          1
! PRESSURE TEST
!  COMP   PRESS
     1    101821.
     2    101821.
$
! PRESSURE CHECK 2 IN WG IN PG "OR" LOGIC.
```

```
!TRIP  TYPE  LOCK IN   NUM TESTS
  5     1      2         1
! PRESSURE TEST
!  COMP   PRESS
    10    101821.
    12    101821.
$
! PRESSURE CHECK 2 IN WG IN SG CELLS "OR" LOGIC.
! TRIP  TYPE  LOCK IN   NUM TESTS
   11    1      2         1
! PRESSURE TEST
!  COMP   PRESS
    50    101821.
    61    101821.
    62    101821.
    63    101821.
    64    101821.
    65    101821.
$
! PRESSURE CHECK 2 IN WG IN PG & SG CELLS "AND" LOGIC
! TRIP  TYPE  LOCK IN   NUM TESTS
  27     5      2         2
! TRIP TEST
!  TRIP    DUMMY
    5       0.
   11       0.
$
! TRIP  TYPE  LOCK IN   NUM TESTS
   6     5      1         1
! TRIP TEST
!  TRIP    DUMMY
    4       0.
   27       0.
$
! TIMER (STARTS TIMER AFTER TRIP 6)
! TRIP  TYPE  LOCK IN   NUM TESTS
   19    6      1         1
! TIME TEST
!   TRIP  TIME
     6    150.
$
! TIMER (STARTS TIMER AFTER TRIP 19)
! TRIP  TYPE  LOCK IN   NUM TESTS
   7     6      1         1
! TIME TEST
!   TRIP  TIME
    19     55.
$
! PRESSURE TO OPEN FILTER VENT AND CLOSE SPECIAL STEAM VENT IF < 3 IN WG
! TRIP  TYPE  LOCK IN   NUM TESTS
   8    -1      2         2
! PRESSURE TEST
!  COMP   PRESS
```

```
     1     102071.
     2     102071.
$
! TIMER + PRESSURE CHECK.
!TRIP  TYPE  LOCK IN   NUM TESTS
  1     5      2          2
! TRIP TEST
!   TRIP     DUMMY
      7        0.
      8        0.
$
! PRESSURE TO OPEN SPECIAL STEAM VENT.
! TRIP  TYPE  LOCK IN   NUM TESTS
   12    1      1          1
! PRESSURE TEST
!  COMP    PRESS
     1   109941.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN RX BLDG C1.
! TRIP  TYPE  LOCK IN   NUM TESTS
   16    1      1          1
! PRESSURE TEST
!  COMP    PRESS
     1   115111.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN PG C3.
! TRIP  TYPE  LOCK IN   NUM TESTS
   17    1      1          1
! PRESSURE TEST
!  COMP    PRESS
    19   115111.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN PG C10.
! TRIP  TYPE  LOCK IN   NUM TESTS
   18    1      1          1
! PRESSURE TEST
!  COMP    PRESS
    10   115111.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN PG C12.
! TRIP  TYPE  LOCK IN   NUM TESTS
   20    1      1          1
! PRESSURE TEST
!  COMP    PRESS
    12   115111.
$
! LOCK IN TEST 1 AND CLOSE SPECIAL STEAM VENT.
! TRIP  TYPE  LOCK IN   NUM TESTS
   13    5      1          1
! TRIP TEST
!   TRIP  DUMMY
     1      0.
$
```

```
! SET TO OPPOSITE OF TEST 1.
! TRIP  TYPE  LOCK IN   NUM TESTS
   14   -5      2          1
! TRIP TEST
!    TRIP   DUMMY
      13     0.
$
! OPEN SPECIAL STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED).
! TRIP  TYPE  LOCK IN   NUM TESTS
   15    5      2          2
! TRIP TEST
!    TRIP  DUMMY
      14    0.
      12    0.
$
! LOCK IN TEST 19 AND CLOSE REGULAR STEAM VENTS.
! TRIP  TYPE  LOCK IN   NUM TESTS
   21    5      1          1
! TRIP TEST
!  TRIP  DUMMY
    19     0.
$
! SET TO OPPOSITE OF TEST 19.
! TRIP  TYPE  LOCK IN   NUM TESTS
   22   -5      2          1
! TRIP TEST
!    TRIP   DUMMY
      21     0.
$
! OPEN REGULAR STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED) IN RX
! TRIP  TYPE  LOCK IN   NUM TESTS
   23    5      2          2
! TRIP TEST
!    TRIP  DUMMY
      22    0.
      16    0.
$
! OPEN REGULAR STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED) IN PG
! TRIP  TYPE  LOCK IN   NUM TESTS
   24    5      2          2
! TRIP TEST
!    TRIP  DUMMY
      22    0.
      17    0.
$
! OPEN REGULAR STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED) IN PG
! TRIP  TYPE  LOCK IN   NUM TESTS
   25    5      2          2
! TRIP TEST
!    TRIP  DUMMY
      22    0.
      18    0.
$
```

```
! OPEN REGULAR STEAM VENT (ONLY IF NOT ALREADY OPENED AND CLOSED) IN PG
! TRIP   TYPE   LOCK IN    NUM TESTS
   26     5       2           2
! TRIP TEST
!     TRIP  DUMMY
       22     0.
       20     0.
$
! RECLOSE PRESSURE CHECK FOR FILTER VENT AT 15 IN WG.
! TRIP   TYPE   LOCK IN    NUM TESTS
   2      1       2           1
! PRESSURE TEST
!  COMP    PRESS
     1     105055.
     2     105055.
$
! TRUE TRIP SET TRUE AT -10 SEC.
! TRIP   TYPE   LOCK IN    NUM TESTS
   9      4       1           1
!  TRIP TEST  TIME
      0        -10.
$
! BLOWOUT OF RX BLDG TO PG VENT.
! TRIP   TYPE   LOCK IN    NUM TESTS
  10     -2       1           1
! PRESSURE TEST JUNCTION 17.
!  TRIP TEST    PRESS
       17       -15513.
$
$
! TABLES FOR JUNCTIONS
!
! OPEN TABLE FOR FILTER VENT
1
!  TIME   %OPEN
     0.     0.
    10.     1.
$
! CLOSE TABLE FOR FILTER VENT
2
!  TIME   %OPEN
     0.     1.
    10.     0.
$
! OPENING TABLE FOR RX BLDG TO PG VENT
3
! DIFF PRESS   %OPEN
      0.          0.
    373.          0.
    622.          1.
$
! OPEN TABLE FOR SPECIAL AND REGULAR STEAM VENTS.
4
```

```
! TIME   %OPEN
   0.      1.
$
! CLOSE TABLE FOR SPECIAL STEAM VENT.
5
! TIME   %OPEN
   0.      1.0
  15.        0.
$
! CLOSE TABLE FOR REGULAR STEAM VENT.
6
! TIME   %OPEN
   0.      1.0
  25.        0.
$
$
! INITIAL WALL TEMPERATURES
!
2*339.
1*477.
3*339.
1*505.
1*339.
29*322.
106*322.
!
! NAMELIST TYPE INPUT
!
! OUTPUT CONTROL VARIABLES
DELTFL = .01
DELVR = .1
! HYDROGEN IGNITION LIMITS
XHMNIG=1.0
! TIMESTEP CONTROL VARIABLES
DTHTMX=3.
DTFLMX=3.
!ESF CONTROLS
SPRAYS=AUTO
! USED TO AVERAGE HEAT FLUX OVER MORE TIME STEPS FOR SMALL VOLUMES.
WFHS=0.2
$
```

APPENDIX F

INPUT DECK FOR COMBUSTION RESPONSE CALCULATIONS (5-VOLUME MODEL)

```
! INITIAL NAMELIST TYPE INPUT
UOA = 9
CMPUTR = CRAY
$ END OF NAMELIST INPUT
!*******************************************
! PROBLEM GEOMETRY AND CONTAINMENT DESCRIPTION
!*******************************************
N REACTOR$

THIS IS A 5 VOLUME DECK USED FOR SCOPING CALCULATIONS OF
COMBUSTION RESPONSE AT N REACTOR

ALL SI UNITS




5 ! NUMBER OF COMPARTMENTS
!
! FOR EACH COMPARTMENT: AN ID, THE VOLUME (M**3), ELEVATION (M), FLAME
! PROPAGATION LENGTH (M), NUMBER OF SURFACES, AND INTEGERS
! SPECIFYING WHICH SUMP TO DUMP EXCESS WATER (FROM SUPERSATURATION)
! INTO AND WHICH SUMP THE SPRAYS FALL INTO.
!
C1-FRONTRXBLD
11243. 9.9  19.8  4 1 1
C2-REARRXBLD
11543. 5.7  19.8  4 2 2
C3-PIPE-GALL
21507. 3.04 57.9  3 3 3
C4-6SG-AUXCELLS
45067. 3.32 15.24 3 3 3
C5-FILTERBLD
3881.  8.35 141.3 2 0 0
!
! FOR EACH SUMP: SUMP NUMBER, MAXIMUM VOLUME (M**3), SUMP NUMBER THAT
! THIS SUMP OVERFLOWS TO
!
! SUMP 1 IS UNDERNEATH THE ELEVATER IN FRONT RX BLDG. WHEN IT FILLS
! WATER FLOWS ONTO THE FLOOR AND INTO DRAINS. IT IS REMOVED FROM THE
! RX BLDG.
1 16.9  0
! SUMP 2 IS THE BANNANA WALL. IT HAS A VERY LARGE VOLUME SINCE IT
! CONNECTS TO THE FUEL POOL; HOWEVER, WE NEGLECT THAT HERE AND CALCULATE
! THE VOLUME IN THE CAVITY ONLY. SINCE WHEN IT OVERFLOWS, THE WATER GOES
! TO THE DRAINS AND IS REMOVED FROM THE RX BLDG, THE EFFECT IS THE SAME
! AS IF WE INCREASED THE VOLUME BUT DID NOT ADD IT TO THE ROOM VOLUME.
2 413.  0
! THERE ARE 6 SUMPS WHICH WE TREAT AS ONE. THIS VOLUME IS LARGER THAN
! THE REAL VOLUME=1497 SINCE WE WANT THE CODE TO CONTINUE TO SUBTRACT
! THE VOLUME OF WATER FROM THE PG AND SG VOLUMES.
3 3000. 0
```

```
$
!
! FOR EACH SURFACE: TYPE OF SURFACE, MASS OF SURFACE (KG), AREA OF
! SURFACE (M**2), CHARACTERISTIC LENGTH (M), SPECIFIC HEAT (J/KG/K),
! EMISSIVITY, INTEGER INDICATING WHICH SUMP THE CONDENSATE GOES INTO.
! FOR SLABS (STYPE = 1), THE NUMBER OF LAYERS IN THE SURFACE, AND FOR
! EACH, THE THICKNESS (M), THERMAL DIFFUSIVITY (M**2/S), AND THERMAL
! CONDUCTIVITY (W/M/K).  FINALLY, THE NODING INFORMATION AND BOUNDARY
! CONDITIONS ARE SPECIFIED (0'S INDICATE HECTR WILL DETERMINE
! THE VALUES INTERNALLY). NOTE THAT SOME OF THE NUMBERS SET TO 1.
! ARE NOT USED FOR THAT SURFACE TYPE.
!
! C1 SURFACES
!
SUMP1
3 15000. 24.55  4.16  1. .94 1
CONC1
1 1. 4143.3 24.3  1. .9  1
1
.3 1.6E-6 2.39
0 0. 0. 0.
CONC1H
1 1. 139.8  9.1   1. .9  1
1
.3 1.6E-6 2.39
0 0. -1.  477.
STEEL1
2 333336. 1597. 1. 531.7 .7 1
!
! C2 SURFACES
!
SUMP2
3 400800. 42.6 5.03 1. .94 2
CONC2
1 1. 4438.6 24.3 1. .9 2
1
.3 1.6E-6 2.39
0 0. 0. 0.
CONC2H
1 1. 139.8 9.1 1. .9 2
1
.3 1.6E-6 2.39
0 0. -1. 505.
STEEL2
2 357665.6 1454. 1. 531.7 .7 2
!
! C3 SURFACES
!
SUMP3
3 45090. 284.3 1.83 1. .94 3
CONC3
1 1. 7562. 15.83 1. .9 3
1
```

```
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL3
2 576146.2 2340. 1. 531.7 .7 3
!
! C4 SURFACES
!
SUMP4
3 45090. 284.3 1.83 1. .94 3
CONC4
1 1. 14810.7 15.4 1. .9 3
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL4
2 1282600. 5364.1 1. 531.7 .7 3
!
! C5 SURFACES
!
CONC5
1 1. 1742.7 68. 1. .94 0
1
.3 1.6E-6 2.39
0 0. 0. 0.
STEEL5
2 243071.5 4907.3 1. 531.7 .7 0
!
!
! CONTAINMENT LEAKAGE INFORMATION
!
! NUMBER OF LEAKS, NUMBER OF PRESSURE AND TEMPERATURE-DEPENDENT
! LEAKAGE CURVES
!
! NOL  NOP  NOT
  11    1    0
! LEAK COMPARTMENT, TEMPERATURE-DEPENDENT LEAKAGE CURVE, PRESSURE-
! DEPENDENT LEAKAGE CURVE, CONTAINMENT FAILURE FLAG, CONTAINMENT
! FAILURE CRITERION, CONTAINMENT FAILURE AREA (M**2), LEAK ELEVATION
! (M), LEAK LOSS COEFFICIENT, L/A FOR LEAK (1/M)
!
! COMP  T CURVE  P CURVE  NCF    CRIT  AREA  ZJI  FLI    LA
! FILTERED RELEASE TO OUTSIDE.
   5      0        0       1       0.   14.3  61.6  1.0    .01
! LEAKS FROM SG CELLS.
   4      0        0       1       0.   .187  -4.9  17.14 .01
   4      0        0       1       0.   .005  10.7  1.0    .01
! VACUUM BREAKER FOR RX BLDG.
   1      0       -1       0     -1723.    1.3  17.8  1.6    .01
! VENT OPENS AT -1723 DIFF PRESS FULL OPEN AT -3446
! REGULAR STEAM VENT IN RX BLDG.
   1      0        0       5  115111.  2.63  17.8  1.74  .01
! VENT CLOSES AFTER 2 IN WG PRESSURE +150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
```

```
!    TRIP  TRIP   TABLE  TABLE  TABLE  TABLE
      24    16     4      1      6      1
!LEAK FROM PG TO OUTSIDE.
  3      0         0      1       0.   .003   -4.9  1.0    .01
! REGULAR STEAM VENTS IN PG (13).
  3      0         0      5  115111. 34.18  10.9  3.01   .01
! VENT CLOSES AFTER 2 IN WG PRESSURE +150 SEC.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP  TRIP   TABLE  TABLE  TABLE  TABLE
      23    16     4      1      6      1
! VACUUM BREAKER IN PG.
  3      0        -1      0     -1723.   1.3  10.9  1.6    .01
! VENT OPENS AT -1723 DIFF PRESS FULL OPEN AT -3446
! LEAK FROM REAR RX BLDG.
  2      0         0      1       0.   .003   12.2  1.0    .01
! LEAK FROM FRONT RX BLDG.
  1      0         0      1       0.   .003   12.2  1.0    .01
! SPECIAL STEAM VENT IN RX BLDG.
  1      0         0      5  109941.  2.63  17.8  1.74   .01
! VENT CLOSES AFTER 2 IN WG +205 SEC + <3 IN WG.
!    OPEN  CLOSE  OPEN   TYPE   CLOSE  TYPE
!    TRIP  TRIP   TABLE  TABLE  TABLE  TABLE
      15    1      4      1      5      1
!
1    1
0. 10.  100.  1000.  1723.  2153.75   2584.5   3015.25  3446. 3876.75
1.E-8 1.E-8 1.E-8 1.E-8 1.E-8  .325      .65        .975     1.3    1.3
0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
!
! FLOW JUNCTION DATA: COMPARTMENT ID'S, TYPE OF CONNECTION, FLOW
! AREA (M**2), LOSS COEFFICIENT, L/A RATIO (1/M), RELATIVE POSITION OF
! COMPARTMENTS, AND JUNCTION ELEVATION (M).
! ADDITIONAL INFORMATION IS PROVIDED FOR JUNCTION TYPE 7.
!
! FROM FRONT TO REAR RX BLDG.
1    2    1  24.2  1.395  .01   0    17.53
! TO FILTER BLDG FROM RX BLDG (FILTER VENT).
1    5    7  7.04 66.26  .01   0    19.74
!  OPEN TRIP  CLOSE TRIP  BLOWN TRIP  ABLOWN
      1           2           3        0.
!  OPEN TABLE  TYPE TABLE  CLOSE TABLE TYPE TABLE
      1           1           2          1
! DUCTS FORM PG TO SG&AUX CELLS.
3    4    1  333.6 1.0   .01   0    8.32
! AUX CELL DOOR.
3    4    1  3.25  2.0   .01   0    2.98
! OPEN CROSS VENT REAR RX BLDG TO PG.
3    2    1  2.37  2.0   .01   1    15.24
! VARIABLE CROSS VENT REAR RX BLDG TO PG.
3    2    7  16.58 2.0   .01   1    15.24
!  OPEN TRIP  CLOSE TRIP  BLOWN TRIP  ABLOWN
      9           3          10        12.88
!  OPEN TABLE TYPE TABLE  CLOSE TABLE TYPE TABLE
```

```
      3              2              3             2
! CROSS VENT BETWEEN REAR RX BLDG (2) AND PG (3)
! 16.58 IS THE FULL OPEN AREA FROM 3 TO 2 AND 12.88
! IS THE FULL OPEN AREA FROM 2 TO 3.  15513 IS THE DP (PA)
! TO SHEAR THE PIN AND OPEN THE DOOR FROM 2 TO 3.
!
! SUMP BETWEEN PG AND SG CELLS
! DO NOT USE IN BASE CASE
! ELEV=-6.4M;AREA=243.24-.1728*VOL(ADDED)
! IF 18.54 M**3 ADDED THEN SUMP PUMPS START .11 M**3/S PER SG CELL.
3       4          6          243.24       2.0       .01      0      -6.4
!    MIN VOL   MAX VOL   SUMP    BLOWOUT
      90       1497.8      3        0
$ END OF JUNCTIONS
$ NO ICE CONDENSER
$ NO SUPPRESSION POOL
$ NO FANS
$ NO FAN COOLER
 !
 ! BEAM LENGTH AND VIEW FACTOR MATRICES
 !
 ! BEAM LENGTHS
 !
  6.854734        6.854734        6.854734        6.854734
 12*0.0
  6.854734        6.854734        6.854734
 12*0.0
  6.854734        6.854734
 12*0.0
  6.854734
 12*0.0
  6.840296        6.840296        6.840296        6.840296
  8*0.0
  6.840296        6.840296        6.840296
  8*0.0
  6.840296        6.840296
  8*0.0
  6.840296
  8*0.0
  7.600914        7.600914        7.600914
  5*0.0
  7.600914        7.600914
  5*0.0
  7.600914
  5*0.0
  7.930027        7.930027        7.930027
  2*0.0
  7.930027        7.930027
  2*0.0
  7.930027
  2*0.0
  2.100992        2.100992
  2.100992
```

```
 !
 ! VIEW FACTORS
 !
  0.0000000E+00  0.7046309      2.3775108E-02  0.2715940
  12*0.0
  0.7016890      2.3675844E-02  0.2704601
  12*0.0
  2.3675842E-02  0.2704601
  12*0.0
  0.2704601
  12*0.0
  0.0000000E+00  0.7357934      2.3174856E-02  0.2410318
   8*0.0
  0.7305974      2.3011198E-02  0.2393296
   8*0.0
  2.3011200E-02  0.2393296
   8*0.0
  0.2393296
   8*0.0
  0.0000000E+00  0.7636841      0.2363159
   5*0.0
  0.7417577      0.2295309
   5*0.0
  0.2295310
   5*0.0
  0.0000000E+00  0.7341188      0.2658812
   2*0.0
  0.7237737      0.2621344
   2*0.0
  0.2621344
   2*0.0
  0.2620601      0.7379398
  0.7379399
!
! NUMBER OF SPRAY TRAINS
2
! FOR TRAIN 1 ( IN RX BLDG C1 AND C2).
!
! NUMBER OF SOURCE COMPARTMENTS
2
! SOURCE COMPARTMENT, INJECTION TEMPERATURE (K), FLOW RATE (M**3/S),
! NUMBER OF DROP SIZES; FOR EACH DROP SIZE: FREQUENCY AND DIAMETER
! (MICRONS)
1 293.15 .26  2
.49   1400.
.51   1100.
2 293.15 .28  2
.65   1400.
.35   1100.
! FOR SPRAY CARRYOVER, THE SOURCE AND RECEIVING COMPARTMENTS AND THE
! FRACTION CARRIED OVER
!
$
```

```
! SPRAY COMPARTMENT AND SPRAY FALL HEIGHT (M)
1  12.65
2  24.1
$
!
! SPRAY ACTUATION CRITERIA FOR THIS TRAIN
!
! NUMBER OF TOP-LEVEL CRITERIA IN "OR" CONFIGURATION
2
! FOR EACH TOP CRITERIA, NUMBER OF 2ND-LEVEL CRITERIA IN "AND"
! CONFIGURATION, AND FOR EACH 2ND-LEVEL CRITERION,
! NUMBER OF COMPARTMENTS TO TEST AND, FOR EACH
! COMPARTMENT TO TEST, THE COMPARTMENT ID AND THE PRESSURE (PA)
! AND TEMPERATURE (K) SETPOINTS.  FINALLY, THE NUMBER OF
! COMPARTMENTS THAT MUST MEET THE SETPOINTS FOR THE CRITERIA
! TO BE MET
!
! TEST COMPARTMENT 1 AND 2 AND ACTUATE IF EITHER IS TRUE "OR".
!
! TEST COMPARTMENT 1 FOR 10 IN WG.
1
1
1 103813.3 0.
1
! TEST COMPARTMENT 2 FOR 10 IN WG.
1
1
2 103813.3 0.
1
!
! DELAY TIME FOR SPRAYS TO START AFTER ACTUATION AND TIME FOR
! SPRAYS TO RUN AFTER STARTING
44. 1.0E10
!
! FOR TRAIN 2 (IN PG ).
!
! NUMBER OF SOURCE COMPARTMENTS
1
! SOURCE COMPARTMENT, INJECTION TEMPERATURE (K), FLOW RATE (M**3/S),
! NUMBER OF DROP SIZES; FOR EACH DROP SIZE: FREQUENCY AND DIAMETER
! (MICRONS)
3 293.15 .076  1
1.0  1690.
! FOR SPRAY CARRYOVER, THE SOURCE AND RECEIVING COMPARTMENTS AND THE
! FRACTION CARRIED OVER
!
$
! SPRAY COMPARTMENT AND SPRAY FALL HEIGHT (M)
3  15.8
$
!
! SPRAY ACTUATION CRITERIA FOR THIS TRAIN
!
```

```
! NUMBER OF CRITERIA IN "OR" CONFIGURATION
1
! FOR EACH TOP CRITERIA, NUMBER OF 2ND-LEVEL CRITERIA IN "AND"
! CONFIGURATION, AND FOR EACH 2ND-LEVEL CRITERION,
! NUMBER OF COMPARTMENTS TO TEST AND, FOR EACH
! COMPARTMENT TO TEST, THE COMPARTMENT ID AND THE PRESSURE (PA)
! AND TEMPERATURE (K) SETPOINTS.  FINALLY, THE NUMBER OF
! COMPARTMENTS THAT MUST MEET THE SETPOINTS FOR THE CRITERIA
! TO BE MET
!
! TEST COMPARTMENT 3 (PG) "AND" 4 (SG CELLS)
1
2
3 103813.3 0.
4 103813.3 0.
2
!
! DELAY TIME FOR SPRAYS TO START AFTER ACTUATION AND TIME FOR
! SPRAYS TO RUN AFTER STARTING
44.  1.0E10
! SPRAY HEAT EXCHANGER INFORMATION
$ NO SPRAY RECIRC
$ NO SUMP HEAT EXCHANGERS
!
60.  10.  ! SIMULATION TIME  AND CPU TIME REMAINING.
!
! INITIAL CONDITIONS
!
! TBULK, PP(1-4), UX
! TEMP  STEAM    N2     O2      H2    CONV GAS VEL
  339.  20500. 63850. 16975.    0.     .3
  339.  20500. 63850. 16975.    0.     .3
  322.  9350.  72660. 19315.    0.     .3
  322.  9350.  72660. 19315.    0.     .3
  322.  9350.  72660. 19315.    0.     .3
! INITIAL CONDITIONS FOR LEAKS
! TATM, PPATM(1-4)
300.  9400. 72621. 19304. 0.
!
! SOURCE DATA
!
! STEAM AND WATER
! COMP, -1 = CONST. SOURCE T, TEMP, SSRCC
   3            3             477.   0
! TIME    RATE     ENTHAPY
   0.0     0.0     9.0156E5
   0.1   16349.2   8.9179E5
   0.2   17620.2   8.9225E5
   0.4   18327.8   8.9272E5
   0.6   18465.6   8.9272E5
   1.0   18293.3   8.9295E5
   1.5   18282.4   8.9318E5
   2.0   18141.8   8.9388E5
```

```
   3.0  17964.4  8.9807E5
   5.0  17190.2  9.2714E5
   6.0  17003.3  9.5343E5
   7.0  16060.7  9.8529E5
   8.0  14970.3  1.0188E6
   9.0  14533.0  1.0516E6
  10.0  13689.3  1.0814E6
  12.0  11281.7  1.1290E6
  15.0  9411.10  1.1737E6
  20.0  8951.10  1.2221E6
  25.0  7414.40  1.2560E6
  30.0  5597.30  1.2837E6
  35.0  3980.70  1.3405E6
  40.0  2624.50  1.4593E6
  43.6  1808.00  1.4763E6
  45.0  2296.10  1.3707E6
  48.4  3859.10  1.0623E6
  50.0  4327.20  9.9739E5
  55.0  4388.00  9.7645E5
  59.0  4201.20  9.6901E5
  60.0  3568.80  1.0439E6
  62.0  3632.30  1.0123E6
  64.0  2805.00  1.1265E6
  66.0  2339.60  1.2023E6
  70.0  1996.70  1.2288E6
  75.0  983.400  1.7184E6
  78.0  1219.30  1.4335E6
  80.0  1246.50  1.4882E6
  84.0  743.000  1.9273E6
  87.0  825.530  1.7368E6
  90.0  840.050  1.6582E6
  93.0  844.580  1.5896E6
  99.0  879.060  1.4775E6
 106.0  876.790  1.4233E6
 112.0  808.300  1.4570E6
 118.0  702.160  1.5145E6
 124.0  699.440  1.5545E6
 134.0  361.060  2.4214E6
 145.0  146.060  2.6633E6
 150.0  64.4100  2.6865E6
 156.0  10.8860  2.7028E6
 156.5   0.0     2.7028E6
3600.0   0.0     2.7028E6
$
$
! NITROGEN
$
! OXYGEN
$
! HYDROGEN
! COMP, -1 = CONST. SOURCE T, TEMP, SSRCC
!   3          -1                1311.   0
    3          -1                 477.   0
```

```
!     TIME              RATE
  +0.00000E+00, +0.00000E+00
  +1.60000E+02, +4.60000E-04
  +3.20000E+02, +9.20000E-04
  +4.80000E+02, +3.22000E-03
  +5.60000E+02, +1.10400E-02
  +6.40000E+02, +2.02400E-02
  +7.20000E+02, +3.31200E-02
  +8.00000E+02, +4.78400E-02
  +8.32000E+02, +5.15200E-02
  +8.80000E+02, +4.23200E-02
  +9.60000E+02, +3.49600E-02
  +1.12000E+03, +2.76000E-02
  +1.28000E+03, +2.24480E-02
  +1.44000E+03, +1.87680E-02
  +1.60000E+03, +1.69280E-02
  +1.76000E+03, +1.47200E-02
  +1.92000E+03, +1.32480E-02
  +2.08000E+03, +1.19600E-02
  +2.24000E+03, +1.08560E-02
  +2.40000E+03, +9.93600E-03
  +2.56000E+03, +9.01600E-03
  +2.72000E+03, +8.64800E-03
  +2.88000E+03, +8.28000E-03
  +3.04000E+03, +8.09600E-03
  +3.20000E+03, +7.91200E-03
  +3.36000E+03, +7.54400E-03
  +3.52000E+03, +7.36000E-03
  +3.68000E+03, +7.17600E-03
  +3.84000E+03, +6.99200E-03
  +4.00000E+03, +6.90000E-03
  +4.16000E+03, +6.80800E-03
  +4.32000E+03, +6.62400E-03
  +4.48000E+03, +6.44000E-03
  +4.64000E+03, +6.25600E-03
  +4.80000E+03, +5.98000E-03
  +4.96000E+03, +5.98000E-03
  +5.12000E+03, +5.88800E-03
  +5.28000E+03, +5.70400E-03
  +5.44000E+03, +5.61200E-03
  +5.60000E+03, +5.56600E-03
  +5.76000E+03, +5.56600E-03
  +5.92000E+03, +5.54300E-03
  +6.08000E+03, +5.52000E-03
  +6.24000E+03, +5.42800E-03
  +6.40000E+03, +5.33600E-03
  +6.56000E+03, +5.24400E-03
  +6.72000E+03, +5.15200E-03
  +6.88000E+03, +5.15200E-03
  +7.04000E+03, +5.06000E-03
  +7.20000E+03, +4.96800E-03
  +7.36000E+03, +4.78400E-03
  +7.52000E+03, +4.69200E-03
```

```
  +7.68000E+03, +4.60000E-03
  +7.84000E+03, +4.50800E-03
  +8.00000E+03, +4.41600E-03
  +8.16000E+03, +4.04800E-03
  +8.32000E+03, +3.95600E-03
  +8.48000E+03, +3.86400E-03
  +8.64000E+03, +3.77200E-03
  +8.80000E+03, +3.68000E-03
  +8.96000E+03, +3.58800E-03
  +9.12000E+03, +3.49600E-03
  +9.28000E+03, +3.40400E-03
  +9.44000E+03, +3.31200E-03
  +9.60000E+03, +3.31200E-03
  +9.76000E+03, +3.22000E-03
  +9.92000E+03, +3.12800E-03
  +1.00800E+04, +2.94400E-03
  +1.02400E+04, +2.76000E-03
  +1.04000E+04, +2.66800E-03
  +1.05600E+04, +2.57600E-03
  +1.07200E+04, +2.39200E-03
  +1.08800E+04, +2.30000E-03
  +1.10400E+04, +2.20800E-03
  +1.12000E+04, +2.11600E-03
  +1.13600E+04, +2.02400E-03
  +1.15200E+04, +1.93200E-03
  +1.16800E+04, +1.84000E-03
  +1.18400E+04, +1.74800E-03
  +1.20000E+04, +1.65600E-03
  +1.21600E+04, +1.56400E-03
  +1.23200E+04, +1.47200E-03
  +1.24800E+04, +1.38000E-03
  +1.26400E+04, +1.28800E-03
  +1.28000E+04, +1.19600E-03
  +1.29600E+04, +1.10400E-03
$
! DOUBLE HYDROGEN RATE FOR SENSITIVITY.
! HYDROGEN
! COMP, -1 = CONST. SOURCE T, TEMP, SSRCC
!   3          -1               1311.   0
!    3          -1                477.   0
!     TIME             RATE
!  +0.00000E+00, +0.00000E+00
!  +1.60000E+02, +9.20000E-04
!  +3.20000E+02, +1.84000E-03
!  +4.80000E+02, +6.44000E-03
!  +5.60000E+02, +2.20800E-02
!  +6.40000E+02, +4.04800E-02
!  +7.20000E+02, +6.62400E-02
!  +8.00000E+02, +9.56800E-02
!  +8.32000E+02, +1.03040E-01
!  +8.80000E+02, +8.46400E-02
!  +9.60000E+02, +6.99200E-02
!  +1.12000E+03, +5.52000E-02
```

```
!  +1.28000E+03, +4.48960E-02
!  +1.44000E+03, +3.75360E-02
!  +1.60000E+03, +3.38560E-02
!  +1.76000E+03, +2.94400E-02
!  +1.92000E+03, +2.64960E-02
!  +2.08000E+03, +2.39200E-02
!  +2.24000E+03, +2.17120E-02
!  +2.40000E+03, +1.98720E-02
!  +2.56000E+03, +1.80320E-02
!  +2.72000E+03, +1.72960E-02
!  +2.88000E+03, +1.65600E-02
!  +3.04000E+03, +1.61920E-02
!  +3.20000E+03, +1.58240E-02
!  +3.36000E+03, +1.50880E-02
!  +3.52000E+03, +1.47200E-02
!  +3.68000E+03, +1.43520E-02
!  +3.84000E+03, +1.39840E-02
!  +4.00000E+03, +1.38000E-02
!  +4.16000E+03, +1.36160E-02
!  +4.32000E+03, +1.32480E-02
!  +4.48000E+03, +1.28800E-02
!  +4.64000E+03, +1.25120E-02
!  +4.80000E+03, +1.19600E-02
!  +4.96000E+03, +1.19600E-02
!  +5.12000E+03, +1.17760E-02
!  +5.28000E+03, +1.14080E-02
!  +5.44000E+03, +1.12240E-02
!  +5.60000E+03, +1.11320E-02
!  +5.76000E+03, +1.11320E-02
!  +5.92000E+03, +1.10860E-02
!  +6.08000E+03, +1.10400E-02
!  +6.24000E+03, +1.08560E-02
!  +6.40000E+03, +1.06720E-02
!  +6.56000E+03, +1.04880E-02
!  +6.72000E+03, +1.03040E-02
!  +6.88000E+03, +1.03040E-02
!  +7.04000E+03, +1.01200E-02
!  +7.20000E+03, +9.93600E-03
!  +7.36000E+03, +9.56800E-03
!  +7.52000E+03, +9.38400E-03
!  +7.68000E+03, +9.20000E-03
!  +7.84000E+03, +9.01600E-03
!  +8.00000E+03, +8.83200E-03
!  +8.16000E+03, +8.09600E-03
!  +8.32000E+03, +7.91200E-03
!  +8.48000E+03, +7.72800E-03
!  +8.64000E+03, +7.54400E-03
!  +8.80000E+03, +7.36000E-03
!  +8.96000E+03, +7.17600E-03
!  +9.12000E+03, +6.99200E-03
!  +9.28000E+03, +6.80800E-03
!  +9.44000E+03, +6.62400E-03
!  +9.60000E+03, +6.62400E-03
```

```
!  +9.76000E+03, +6.44000E-03
!  +9.92000E+03, +6.25600E-03
!  +1.00800E+04, +5.88800E-03
!  +1.02400E+04, +5.52000E-03
!  +1.04000E+04, +5.33600E-03
!  +1.05600E+04, +5.15200E-03
!  +1.07200E+04, +4.78400E-03
!  +1.08800E+04, +4.60000E-03
!  +1.10400E+04, +4.41600E-03
!  +1.12000E+04, +4.23200E-03
!  +1.13600E+04, +4.04800E-03
!  +1.15200E+04, +3.86400E-03
!  +1.16800E+04, +3.68000E-03
!  +1.18400E+04, +3.49600E-03
!  +1.20000E+04, +3.31200E-03
!  +1.21600E+04, +3.12800E-03
!  +1.23200E+04, +2.94400E-03
!  +1.24800E+04, +2.76000E-03
!  +1.26400E+04, +2.57600E-03
!  +1.28000E+04, +2.39200E-03
!  +1.29600E+04, +2.20800E-03
!$
$
$ NO WATER REMOVAL FROM SUMPS
$ NO COMPARTMENT ENERGY SOURCES
$ NO CONTINUOUS BURNING COMPARTMENTS
!
! TRIP LOGIC FOR JUNCTIONS
!
! FALSE TRIP SET TO FALSE AT -10 SEC.
! TRIP  TYPE  LOCK IN  NUM TESTS
   3    -4       1         1
! TIME TEST
!   TRIP TEST  TIME
       0       -10.
$
! PRESSURE CHECK 2 IN WG IN RX BLDG C1 & C2 "OR" LOGIC.
! TRIP  TYPE  LOCK IN NUM TESTS
   4     1       2        1
! PRESSURE TEST
!  COMP   PRESS
     1    101821.
     2    101821.
$
! PRESSURE CHECK 2 IN WG IN PG &SG CELLS "AND" LOGIC.
! TRIP  TYPE  LOCK IN NUM TESTS
   5     1       2        2
! PRESSURE TEST
!  COMP   PRESS
     3    101821.
     4    101821.
$
! OR PRESSURE CHECKS IN RX BLDG AND PG &SG.
```

```
! TRIP  TYPE  LOCK IN  NUM TESTS
   6     5      1         1
! TRIP TEST
! TRIP  DUMMY
   4     0.
   5     0.
$
! TIMER (STARTS AFTER TRIP 6).
! TRIP  TYPE  LOCK IN  NUM TESTS
  16     6      1         1
! TIME TEST
!   TRIP    TIME
      6      150.
$
! TIMER (STARTS AFTER TRIP 16).
! TRIP  TYPE  LOCK IN  NUM TESTS
  7      6      1         1
! TIME TEST
!   TRIP    TIME
     16      55.
$
! PRESSURE TO OPEN FILTER VENT AND CLOSE SPECIAL STEAM VENT IF < 3 IN WG
! TRIP  TYPE  LOCK IN  NUM TESTS
  8     -1      2         2
! PRESSURE TEST
!   COMP    PRESS
      1     102071.
      2     102071.
$
! TIMER + PRESSURE CHECK.
! TRIP  TYPE LOCK IN  NUM TESTS
  1      5     2         2
! TRIP TEST
!  TRIP   DUMMY
     7     0.
     8     0.
$
! PRESSURE TO OPEN SPECIAL STEAM VENT.
! TRIP  TYPE LOCK IN  NUM TESTS
  12     1     1         1
! PRESSURE TEST
!  COMP    PRESS
     1    109941.
$
! PRESSURE TO OPEN REGULAR STEAM VENTS IN PG.
! TRIP  TYPE LOCK IN  NUM TESTS
  17     1     1         1
! PRESSURE TEST
!  COMP    PRESS
     3    115111.
$
! PRESSURE TO OPEN REGULAR STEAM VENT IN RX BLDG.
! TRIP  TYPE LOCK IN  NUM TESTS
```

```
   18     1      1          1
! PRESSURE TEST
!   COMP     PRESS
     1     115111.
$
! LOCK IN TEST 1 AND CLOSE SPECIAL STEAM VENT.
! TRIP   TYPE LOCK IN   NUM TESTS
   13     5      1          1
! TRIP TEST
!    TRIP    DUMMY
      1       0.
$
! SET TO OPPOSITE OF TEST 1.
! TRIP   TYPE LOCK IN   NUM TESTS
   14    -5      2          1
! TRIP TEST
!    TRIP    DUMMY
     13       0.
$
! OPEN SPECIAL STEAM VENT ONLY IF NOT ALREADY OPENED AND CLOSED).
! TRIP   TYPE LOCK IN   NUM TESTS
   15     5      2          2
! TRIP TEST
!   TRIP   DUMMY
    14     0.
    12     0.
$
! LOCK IN TEST 16 AND CLOSE REGULAR STEAM VENTS.
! TRIP   TYPE LOCK IN   NUM TESTS
   21     5      1          1
! TRIP TEST
!    TRIP    DUMMY
      16      0.
$
! SET TO OPPOSITE OF TEST 1.
! TRIP   TYPE LOCK IN   NUM TESTS
   22    -5      2          1
! TRIP TEST
!    TRIP    DUMMY
     21      0.
$
! OPEN REGULAR STEAM VENT IN C3 (ONLY IF NOT ALREADY OPENED AND CLOSED).
! TRIP   TYPE LOCK IN   NUM TESTS
   23     5      2          2
! TRIP TEST
!   TRIP   DUMMY
    22     0.
    17     0.
$
! OPEN REGULAR STEAM VENT IN C1 (ONLY IF NOT ALREADY OPENED AND CLOSED).
! TRIP   TYPE LOCK IN   NUM TESTS
   24     5      2          2
! TRIP TEST
```

```
! TRIP  DUMMY
   22    0.
   18    0.
$
! RECLOSE PRESSURE CHECK FOR FILTER VENT AT 15 IN WG.
! TRIP  TYPE LOCK IN  NUM TESTS
  2     1    2          1
! PRESSURE TEST
!  COMP    PRESS
    1     105055.
    2     105055.
$
! TRUE TRIP SET TO TRUE AT -10 SEC.
! TRIP  TYPE LOCK IN  NUM TESTS
  9     4    1          1
! TRIP TEST
!   TRIP TEST   TIME
       0        -10.
$
! BLOWOUT OF RX BLDG TO  PG VENT.
! TRIP  TYPE LOCK IN  NUM TESTS
  10   -2    1          1
! PRESSURE TEST JUNTION 6
!  TRIP TEST   PRESS
     6        -15513.
$
$
! TABLES FOR JUNCTIONS
!
! OPEN TABLE FOR FILTER VENT
1
!   TIME  %OPEN
      0.   0.
     10.   1.
$
! CLOSE TABLE FOR FILTER VENT
2
!   TIME  %OPEN
      0.   1.
     10.   0.
$
! OPENING TABLE FOR RX BLDG TO  PG VENT
3
!  DIFF PRESS  %OPEN
      0.         0.
    373.         0.
    622.         1.
$
! OPEN TABLE FOR SPECIAL AND REGULAR STEAM VENT .
4
!   TIME  %OPEN
   0.     1.
$
```

```
! CLOSING TABLE FOR SPECIAL VENT.
5
!    TIME   %OPEN
      0.     1.0
     15.     0.0
$
! CLOSING TABLE FOR REGULAR STEAM VENT.
6
!    TIME   %OPEN
      0.     1.0
     25.     0.0
$
$
! INITIAL WALL TEMPERATURES
!
2*339
1*477
3*339
1*505
1*339
8*322.
!
! NAMELIST TYPE INPUT
!
! OUTPUT CONTROL VARIABLES
DELTFL = .01
DELVR = .1
! HYDROGEN IGNITION LIMITS
XHMNIG=1.0
! TIMESTEP CONTROL VARIABLES
!ESF CONTROLS
SPRAYS=AUTO
$
```

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